DISCOVERY

THE MAGAZINE OF SCIENTIFIC PROGRESS

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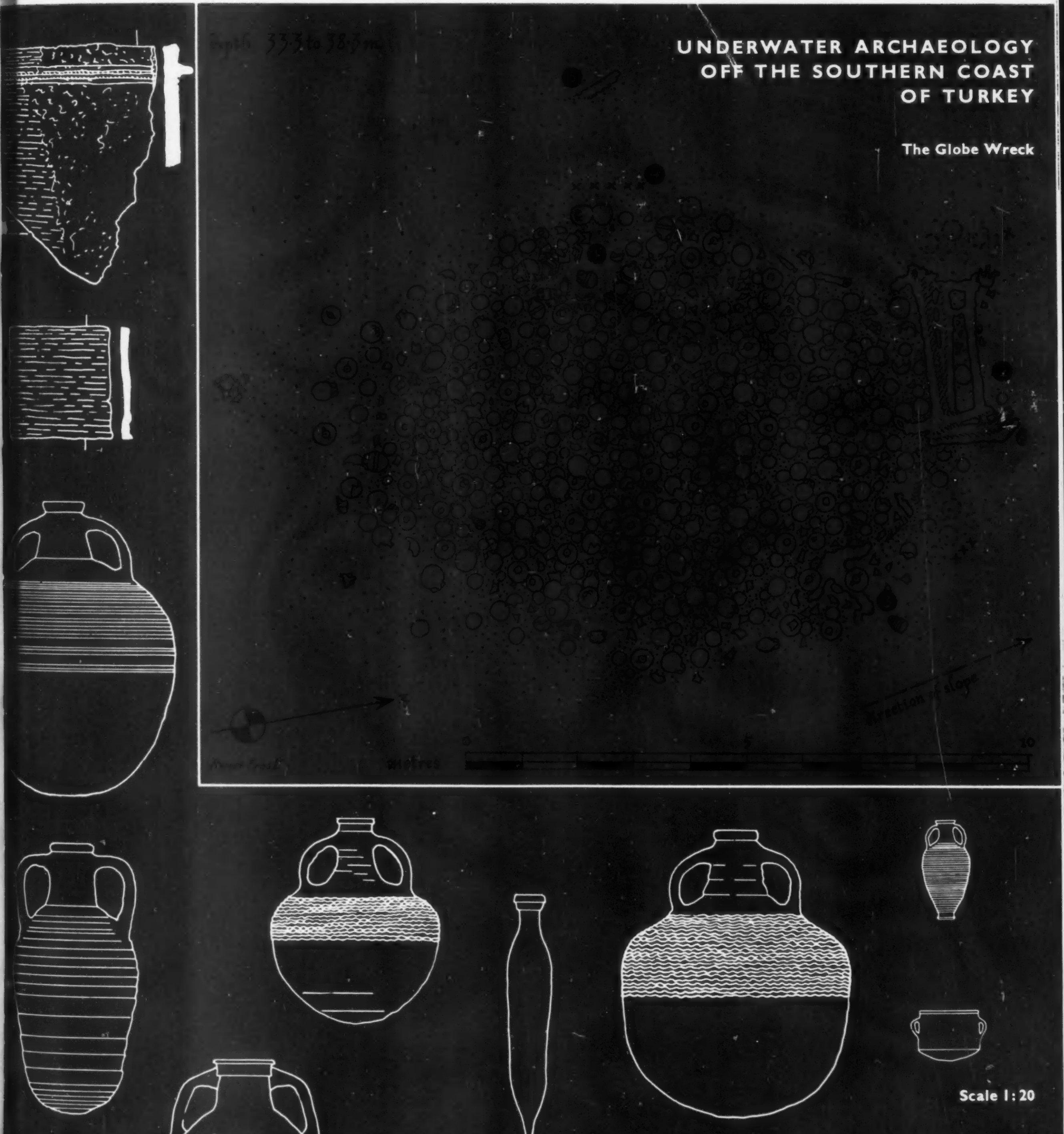
MAY 1960 3/-

UNDERWATER ARCHAEOLOGY OFF THE SOUTHERN COAST OF TURKEY

The Globe Wreck



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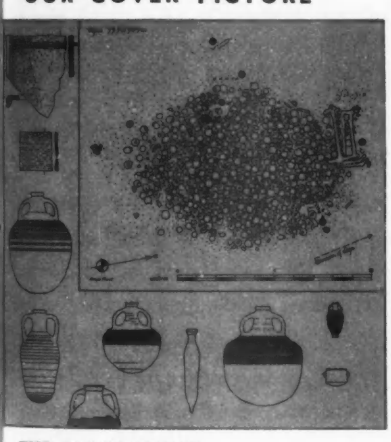


THE GLOBE WRECK

Main Drawing:
1. Galley area.
2. Concreted, iron spare-anchors.
3. Concreted, iron kedge anchor.
4. Soundings where wood has been located.
5. Concreted, iron object sticking out of sand at an angle of 45 degrees.

The plan is framed by pottery representative of the cargo.

The plan of the wreck is the first scientific underwater archaeological plan to be made, and was drawn by Miss Frost entirely underwater. Her article on the expedition appears on p. 194.

The drawing is by Miss Honor Frost.

CONTENTS

THE PROGRESS OF SCIENCE

THE MINISTER FOR SCIENCE

It is six months since we expressed in our leading article, "Science and the New Government", the hope that with a new Parliament and a Minister for Science, the cause of science in our national affairs would prosper. Six months is hardly time to pass judgment on our new arrangements, but it suffices for reflecting on major issues.

We profoundly welcome the promptitude with which Parliament has turned to a discussion of the future of science. The challenge implicit in Lord Hailsham's description of his task is not merely one to a Minister for Science alone: it is a challenge to the framework of the political institutions in which British science operates. For effectively, the Minister sees scientists functioning independently in a climate of intellectual freedom, along with Parliamentary accountability for expenditure and overall guidance by the Government. His conception of the new office is evolutionary, and while this accords with Britain's political traditions, nevertheless the inherent modesty of the new proposals does carry with it certain implications. While we do not advocate some vast super-Ministry and bureaucracy, the fact that the Minister's new Department is small, thirty-nine in all, of whom five are doorkeepers and only two are scientists, is bound, whatever the calibre of the largely administrative staff, to circumscribe what the Minister himself can do. For the policy guidance which he personally can supply must be very limited, and he may well be in a weak position when confronted with conflicting advice from the scientific agencies for which he is responsible. Then again, the fact that the Minister is a member of the Lords, while six different Ministers answer for his functions in the Commons, does not bode well for co-ordination and can only mean that the full status of science within our political counsels is far from established.

This attitude of caution or modesty is most dramatically seen in Britain's space programme. The Government's decision of last summer, reiterated in the recent advice of the Advisory Council for Scientific Policy, not at present to undertake a major programme of space exploration, but to concentrate on a modest programme of sending up instruments in American space satellites, has not been adequately debated. This may well be because public opinion, still insufficiently informed, is inclined to be apathetic. Thus, a Gallup Poll published in the *News Chronicle* last year revealed only half the population as favouring Britain's doing something about space-travel, and only 12% of these as being willing to pay more taxes for this purpose. Whatever our views on the soundness of the Government's decision, it clearly requires fuller justification. Some of our contemporaries criticise the cult of prestige in science or express misgivings about the cost-aspects of a space programme, but there is equally understandable anxiety about the consequences of a policy which could imply our abdication from space. It is true that the Government's decision is an interim one, and that it leaves open the possibility of an international co-operative effort through, for instance, COSPAR. Nevertheless while the search for co-operation must be pressed, there clearly must be some time-limit. For, to quote *The Times,* one thing is indeed unacceptable, namely, "that Britain should take no part either individually or co-operatively in satellite launching and all the important technical challenges that it entails". We cannot here set out the full range of scientific arguments for Britain's going into space, but aside from the cost-difficulty, the beneficial economic and industrial effects from such activity could be considerable, nor should we ignore the decline in this country's influence which would otherwise be implicit. Hence we restate our plea, rendered more urgent by the recent controversy about *Blue Streak,* for the fullest national debate of the issue, extending not merely to the provisional character of the Government's decision, but also to the character of the advice given by the Advisory Council for Scientific Policy. The argument that this body has not the right balance of expertise to do full justice to space research cannot be entirely dismissed. At all events, it fully vindicates the case for strengthening the advice which can be made available to the Minister for Science.

A similar development is necessary if there it to be the most effective application of science to industry. We concede that the problem is not a simple one. A backward company is not changed merely by building laboratories and hiring graduates. It is not enough simply to ensure that industry makes fuller use of science. It is even more important to make sure that science is enlisted in pursuit of specific and useful aims. Such statements may seem at first sight truisms, but it is clear that our existing arrangements do not permit the effective application of science to industry. For, as Profs Carter and Williams contend in their newest study, "Science in Industry", "we doubt if it can be said that a Government policy on the application of science really exists. The facts on which such a policy should be based have still to be collected and assessed . . ." We stress that if the Minister for Science is to speak with the voice of science in the Cabinet, the advice on which he can draw must be substantially reinforced.

Unquestionably, the task of a Minister for Science is a difficult one. He is likely in the foreseeable future to meet a shortage of scientific resources and manpower, and he will have to discriminate between competing projects. For that reason the battle for scientific manpower is Britain's contemporary Battle of the Atlantic. How can we remain complacent when one authority estimates that despite our efforts the number of science graduates or graduate-equivalents trained is rising some 2½–3% per annum in this country, compared with 3½% in the United States and 7½% in the Soviet Union? Can we be confident that the Government's scientific man-power targets are not set too low, that their caution notably with regard to possible unemployment among biology graduates reflects an unfortunate pessimism about the true potentialities in this vital area, that the supply of science teachers in schools and particularly in girls' schools is all that it should be? There is a vast job for the Minister to do. We devoutly hope that he will stand in the van of progress and not in some ministerial backwater.

OCEANOGRAPHY IN BRITAIN

Few people would suspect that the large red-brick building in Wormley, between Godalming and Guildford in Surrey, houses the National Institute of Oceanography. Governed by a council of eminent scientists and financed by contributions from the Admiralty, the Development Commission, Commonwealth Governments, and the occasional sale of its own designs of research instruments, the Institute is really a large team of mathematicians, physicists, chemists, biologists, engineers, and technicians who now number over fifty. In spite of being far from the sea, this very fact has the advantage that theoretical research can go on undisturbed by the always busy scene of the harbour and the port, and that a far more thorough thinking-through of any new device must be accomplished before it is tried out at sea. Barely ten years old, the Institute, under its director, Dr G. E. R. Deacon, F.R.S., has already gained for itself a world reputation and is in close contact with other similar institutes abroad, like Woods Hole in the U.S.A., and the Laboratoire d'Oceanographie Physique in Paris.

As a pure science, Oceanography is of very recent origin, and few of its basic measurements are older than fifty years. As an applied science, however, fishermen and mariners have, during the centuries, accumulated a vast store of useful, but often completely unco-ordinated, data. Agriculture before the use of artificial fertilisers, and metallurgy before the introduction of the spectroscope, were equally primitive. Judging from other interactions between the pure and the applied sciences, sea-technology is likely to benefit enormously from an increase in theoretical oceanographic knowledge.

Oceanography integrates all the marine sciences: such as the physical and chemical properties of sea-water, as for example its distribution of temperature, salinity and density, both horizontally and vertically; such as the sea as a biological environment, the animal and plant populations of the sea, their observation and collection; the static and dynamic aspects of ocean currents, of waves and of tides—and the many interrelationships of the individual branches of the subject. As all the oceans and seas occupy 70% of the Earth's surface, the immense task confronting oceanographers becomes apparent. Not only the gigantic size of the uncompleted work, but also the very great technical difficulties of doing research from and aboard a sea-going ship must be held responsible for the fact that we know so little of the sea as compared with the 30% of land surface of the Earth. For example, to measure the Earth's gravity at sea demands an instrument accurate to one part per million, and this must work when the ship rolls perhaps through an angle of 40° each way; this is by no means an easy specification to meet.

It is standard practice to equip special ocean-going research vessels for such work at sea, and the famous names of the British *Discovery I* and *II*, the German *Meteor*, the American *Atlantis*, the French *Calypso*, and the Danish *Galathea* spring to mind. They have carried their research instruments to specific points on the oceans and have there made their observations and collections. From such isolated points on the surface of the sea have come many important data and discoveries of new facts and there can be no doubt that this method of research must be greatly expanded in the future, although the evaluation of new material may take ten times as long as its collection on the spot. But a new factor has now entered oceanography, namely the use of electronic recording gear and the subsequent semi-automatic evaluation of results by computers, with its inherent advantage of speedy results. Another recent trend is the construction of instruments working independently from the ship, either floating on the surface, or at a predetermined depth, or sinking to the floor of the ocean. It has been found with these instruments that it is often an advantage to make them expendable, and to let them transmit their results acoustically back to the ship. (See DISCOVERY, 1957, vol. 18, No. 9, p. 386.)

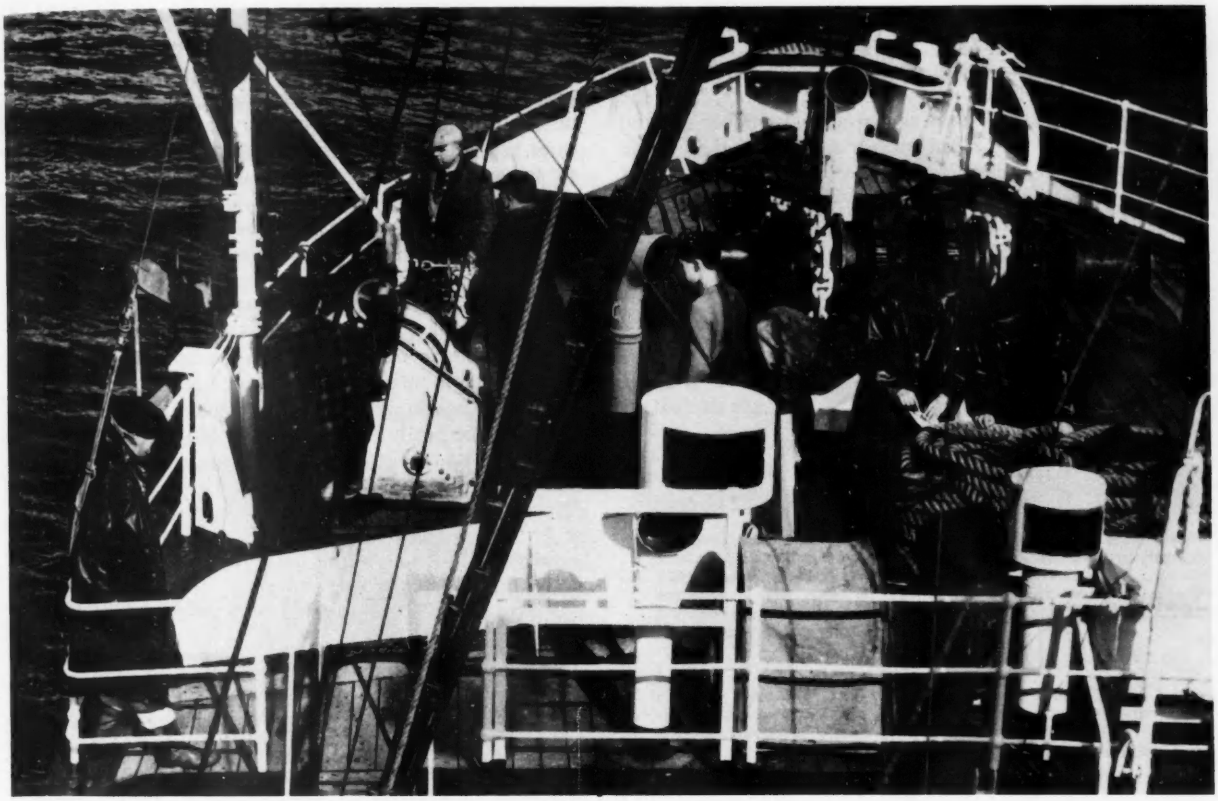
A third new development is the continuous recording on board a research ship of geophysical data, like gravity, or the precision sounding of great depth of the sea. Such a continuous record is a great advance over the isolated measurements, often perhaps 100 km. apart, but it is not an easy measurement to obtain, as it demands the development of new ancillary techniques. For example, a shipborne gravimeter needs a platform stabilised by three gyroscopes, and the precision depth-sounder must be suspended outside the ship and towed in a separate fin-stabilised casing. It is in the design and in the engineering of new oceanographic research instruments that the British Institute at Wormley has perhaps made one of its most outstanding contributions so far. Their deep-sea drift tubes, the "pingers", and their shipborne wave-recording instrument are now standard throughout the world and have been purchased by American, French, and Russian scientists for their own work.

Oceanography has now reached the stage where it deserves the serious attention of British universities. It is high time that such an important subject should be available for post-graduate students, and what better place for their studies could be found than the Institute of Oceanography. Apparently there are only facilities at Liverpool University for the academic study of this young science.

OCEANOGRAPHIC INSTRUMENTS

A number of other research instruments are noteworthy. A polypropylene water sampling bottle is in an advanced stage of trials and was recently tested most satisfactorily at depths of 4700 m. Ingenious is the design of the totalising current meter that can be used by fishermen to measure the movement of water past a static point, over a period of two or three days.

Small phosphor-bronze balls are released from a central reservoir dropping down through a conical compass housing, into one of a number of separate compartments. As the direction of the current changes, the compass bearing remains stationary, and the compartments move round beneath it, thus the number of balls in each compartment gives a direct reading of the current and direction. A deep-sea tide recorder, depending for its function on a system of oil-filled bellows, and a shipborne wave recorder working on the principle of integrating accelerometers are also important new instrumentation devices. At the pier of



On board *Discovery II* at a research station in the Bay of Biscay during February this year. On the left of the fo'c's'le is the hydrographic winch from which the N.I.O. water-bottles were lowered.

(Photograph by courtesy of Mr C. A. Herbert, Chief Engineer, Discovery II*)*

Eastbourne, the Institute has recently placed its new Frequency Modulated Pressure Recorder and for the fishery industry it has developed a Fish Detection Transducer, similar in principle to Asdic, but servo-controlled against pitch and roll. For the correlation of storms at sea with earth tremors, a Horizontal Two-Component Seismograph which records and self-analyses horizontal ground accelerations over periods of one second, and a Vertical One-Component Seismograph are now available. In order to reproduce waves under laboratory conditions—so far in shiptanks these waves have always been of uniform size—the Institute has now developed a special Wave Maker capable of producing waves of different magnitudes, following a detailed programme recorded on punched cards. Other new instruments are the Photometric Drum Analogue Computer for the correlation and evaluation of two related sets of data, and a Bottom Current Meter in which the results are photographically recorded at regular intervals while the meter is anchored to the sea bottom. In addition to all these special devices, the design and engineering staff at the Institute is constantly engaged in the improvement of standard oceanographic equipment like winches, trawling and hauling gear, deep sea photographic and cinematographic cameras, and so forth. It is a truism to state that a science progresses as fast as the instruments on which it depends; oceanography will certainly be a flourishing science when all these instruments, and other developments still on the drawing board, have been thoroughly tried at sea and have come into general use.

THE N.I.O. WATER-BOTTLE

One of the new instruments developed at the National Institute of Oceanography is a plastic water-bottle designed to bring back to the surface of the ocean a sample of water, about 1·3 litre in capacity. In addition, each bottle generally carries two thermometers to indicate the temperature at which this sample has been taken, and also a pressure-recording instrument, in fact a third thermometer which is affected by pressure as well as temperature. Metallic water-bottles have been in existence for many years, but are by no means perfect. First, they are too heavy, which limits the number of them that can be used on any given length and diameter of wire on which they are lowered in the sea. They are difficult to clean, unless completely dismantled; the previous design did not permit a complete flow-through of water prior to sampling; and the sample is contaminated unless the bottle is lined with silver, resistant enamel, or plastic coating, all rather difficult and expensive. Hence the Institute decided about nine months ago to design an entirely new plastic water-bottle, as free from these defects

as possible: the team responsible for the design were F. E. Pierce, D. I. Gaunt, and R. Dobson.

The N.I.O. water-bottle consists mainly of a cylinder made of ½-in.-thick polypropylene, open at both ends; the ends can be closed by two hemispherical, rubber-covered caps, actuated by heavy coil springs attached to the outside of the cylinder. As the cylinder is lowered, the water rushes through it, and only that sample of water is brought back to the surface which is trapped in the cylinder at the moment when the springs are released and the caps close the two ends of the cylinder. As the caps are held closed by spring pressure only, they do not bottle up the high pressure that exists at great depth; when the bottle reaches the surface the internal and external pressures are equal. The sample is drawn from the cylinder by opening a small tap at the bottom, air being allowed to enter through a similar vent at the top.

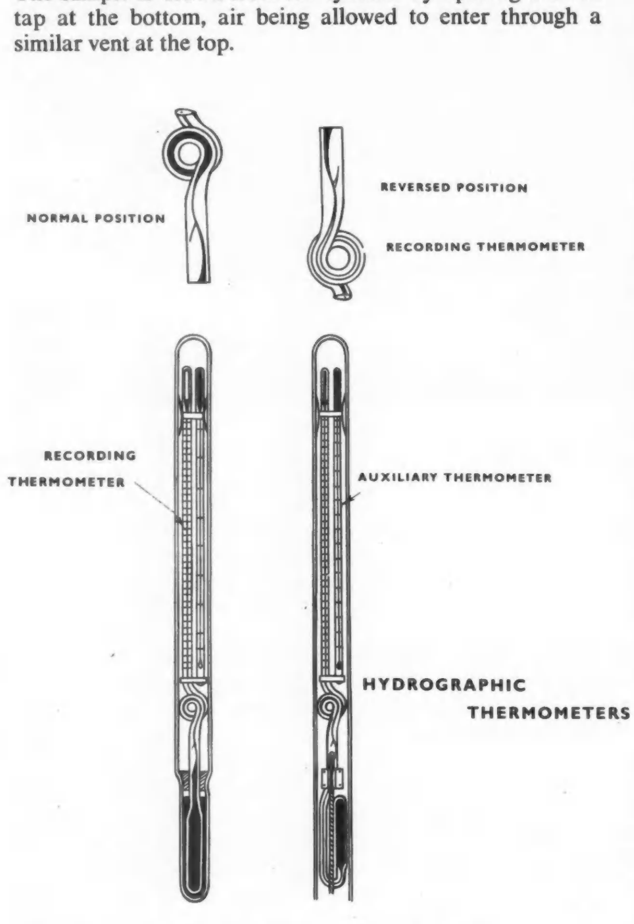


Diagram of the two types of reversing thermometer, with on the left the temperature-recording, and on the right the pressure-recording type. Both are reversed through 180° to fix the thread of the mercury in a permanent position when the water sample is taken.

In a separate framework attached to the cylinder, three thermometers are carried. Two of these record the temperature, the third the pressure. They are all three of the reversing type, that is to say, that if they are suddenly turned through 180°, the mercury breaks, and thus indicates the reading at the instant of reversing, regardless of subsequent changes of temperature. Each of the two temperature-recording thermometers is totally enclosed inside a strong outer tube and thus give a true reading of the temperature; the third, the pressure-recording thermometer, is not protected from pressure, and thus, depending on the depth, its bulb is slightly compressed by the ambient water pressure. Using a simple formula and previous calibration the difference in reading between the open and the totally enclosed thermometers allows a calculation of the pressure, and therefore the depth, at the moment of reversal. In the N.I.O. water-bottle, in contrast to most others, only the framework carrying the three thermometers is reversed; this happens at the same instant as the end caps close the plastic cylinder and trap the water sample.

At sea, a short length of special 4 mm. diameter galvanised steel wire, with a weight attached, is run from a winch, and the first water-bottle fixed to it by means of a clamping screw. Further lengths of wire are then run off, and additional water-bottles fixed to the wire, say at intervals of 500 to 1000 m. When a string of bottles is thus suspended from the ship at its chosen station, an extremely simple and highly ingenious procedure that has been used for fifty years or more is set in motion. A "messenger" is attached to the wire on board the ship and allowed to slide down, reaching soon its terminal velocity of about 300 m./min. When this small brass weight hits the release mechanism of the first water-bottle, it performs three tasks; it actuates the closing mechanism of the two caps and thus imprisons a water sample in the cylinder; secondly, it allows the thermometer frame to reverse through 180°; and thirdly, it allows a second "messenger"—attached to the bottle before lowering it into the sea—to fall down from the first to the second bottle, there to repeat the operation. Another messenger leaves the second bottle to actuate the third, and so forth until the whole string of bottles has been actuated and a vertical cross-sectional sample of the sea water has been taken.

These new bottles were recently tested from *Discovery II* during a research voyage in the Bay of Biscay, at depths down to 4700 m. Their performance fulfilled the expectations of their designers, but some minor modifications were found necessary. These are now being made at the Institute, in time for the bottles to be put into service this summer.

DRACONE PROVES ITSELF

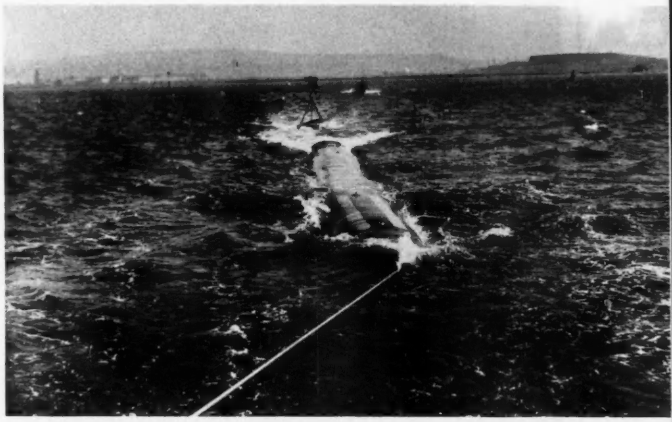
In August 1958, the first operational Dracone was launched at Southampton. It is a new idea for transporting and storing liquids at sea and was conceived by a group of Cambridge scientists under Prof. W. R. Hawthorne, F.R.S. It was taken up and developed by Dracone Developments Ltd. Intensive tests were carried out at the National Physical Laboratory on a model scale to determine drag and general behaviour of this type of conveyance. As good results were obtained the Development Company was formed

under the sponsorship of the National Research Development Corporation, and a small model, 3 ft. in diameter and 67 ft. long, was made and tested. This proved most satisfactory and the Dracone seems now well on the way to becoming established.

A Dracone can best be described as a sausage-like vessel which can transport any liquid lighter than sea-water: though primarily invented to carry petroleum oil, it can also transport liquid chemicals and alcohol. It is made from woven nylon fabric with synthetic rubber coatings inside to resist petrol and fuel oil, and outside to resist sea-water and sunlight. The first operational barge was 100 ft. long and 5 ft. in diameter and had a capacity of 10,000 gallons.

Doubts were expressed not only on the economic value (which is often difficult to assess in a new venture) but also on the general uses of Dracone. What advantages did it, in fact, have over the conventional oil tanker? First, one launch can tow a number of Dracones which can be joined together in a long string with nylon rope. Then, at the end of the journey the liquid cargo is pumped out through a self-sealing hose connexion at the end of the barge—at the same time the other end is wound on to a squirrel cage, so that a high pressure is retained at the open end and the pumping speed is kept up. The empty vessel can then be cleaned and sterilised with boiling water and, if there is no return cargo, it can be packed flat for the next journey which can be made by land, sea, or air. Repairs are simple—a puncture can be mended with an ordinary repair kit, such as is carried in lifeboats. Fire hazards are not great as every barge is filled to capacity and there are no air spaces and, therefore, no possibility of an explosive air-gas mixture.

The barges are now used fairly extensively on short journeys around the British Isles, and have proved their worth in seas up to 9 ft. However, one of their greatest values in the future will probably lie in the transportation of liquids to places which are inaccessible to conventional oil tankers. This idea was first considered in Nigeria and a cargo of kerosene was towed 230 miles along narrow, and often shallow and overhung creeks and rivers. The barge sustained no damage and its manoeuvrability was proved—as it is flexible a kink forms at the greatest pressure-point during a turn, so it can turn in its own length.

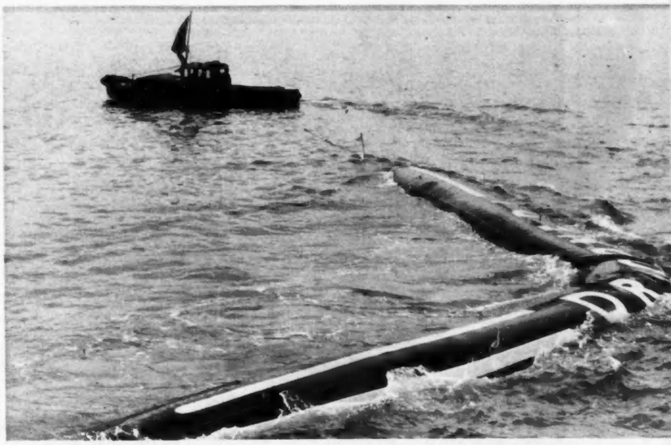


(*Above*) A deep-sea trial of Dracone flexible vessel was recently completed by the Heavy Organic Chemicals Division of Imperial Chemical Industries Limited and Dracone Developments Limited. A trial cargo of liquid hydrocarbons was satisfactorily transported from the ICI works at Billingham, County Durham, to Flushing in Holland.

(*Below*) Here the Dracone kinks to follow the towing launch during turns at various speeds, thereby giving manoeuvrability even in a crowded waterway.

(Photograph by courtesy of Central Press Photos Ltd)

(*Left*) At the end of a journey the emptied Dracone can be rolled up on a squirrel cage, as is demonstrated here during one of its recent trials in Africa.



A final judgment cannot be made on the Dracone for several years because it will not be known until then how the barges stand up to continuous work—though naturally the vessel being towed in open waters will last longer than the one working in narrow creeks where it will have constant friction from overhanging bows and narrow banks. However, this venture is no flash in the pan, it was preceded by many months of hard, painstaking work which should pay dividends.

PHOTOGRAPHING SQUID IN MID-WATER

Squid occur in large numbers in the sea and play an important part in its economy. Because of their size and the speed with which they move the larger oceanic species are not taken in conventional nets and little is known of their habits and distribution. In the past information on these animals could only be obtained from specimens taken in hand-nets at the surface and from the stomach contents of sperm whales which feed on them. Now the underwater camera has made it possible to study their habits in deep water where they are known to occur to a depth of at least 3000 ft.

The chance of seeing a squid, or any other sizeable organism, in a random series of mid-water photographs is extremely low since the actual density of animals in the sea is small. Therefore, to photograph one, it is necessary both to attract the squid to the camera and then to use an automatic method of photography when it is there.

In the system developed at the National Institute of Oceanography, the squid is attracted by a baited hook mounted on a long arm. The deep-sea camera, specially built to work at high pressures, is directed at the bait and is triggered whenever the bait is pulled. This is achieved by using the arm as a spring-loaded lever to operate a small switch on the base of the camera frame.

When the bait is pulled, the flash-light fires and the picture is taken. Automatically, the film is moved on to the next frame and is ready for another picture in about 15 seconds. If a squid is actually caught on the hook, as it tries to escape, it takes photographs of itself every 15 seconds or so.

The camera is lowered over the side of the ship to a depth where squid may be found, and is left there for a period of four or five hours during which time squid may be attracted to the bait. Sometimes a station yields no photographs but occasionally one is lucky enough to get a series as shown on the opposite page.

These photographs were taken at a depth of 1200–1500 ft. off the Dersertas Islands in the Madeira group, and have been selected from a series of thirty which depict a battle between two squid, one of which (Fig. 2) has been foul-hooked by the tail. Some idea of the scale is given by the mark on the rod which is 3 in. from the end. The squid appear to be between 1 and 2 ft. in total length.

Squid do not hesitate to attack another of their kind that is at a disadvantage and in the next photograph (Fig. 3) the animals have their arms interlocked as they grapple head to head. The hooked squid already bears evidence of the attack in the light patches where pieces of skin have been torn off.

At a later stage (Fig 4) the assailant changes its grip to the body, its arms encircling its opponent and leaving marks where the suckers have still further damaged the delicate skin. Towards the end of the battle (Fig. 5) the now helpless squid hangs limply from the hook while its head is attacked once again.

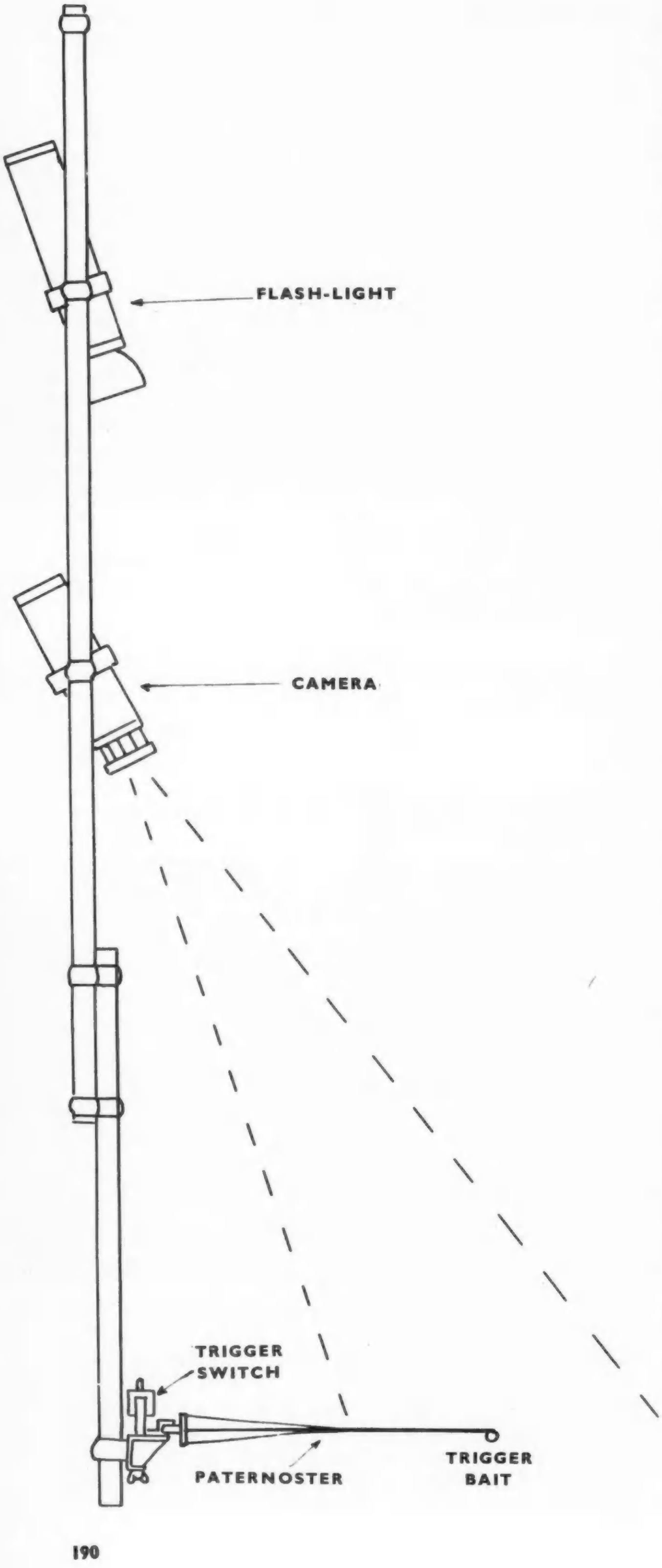


Diagram of the camera set-up for mid-water photography.

Photographs by courtesy of the National Institute of Oceanography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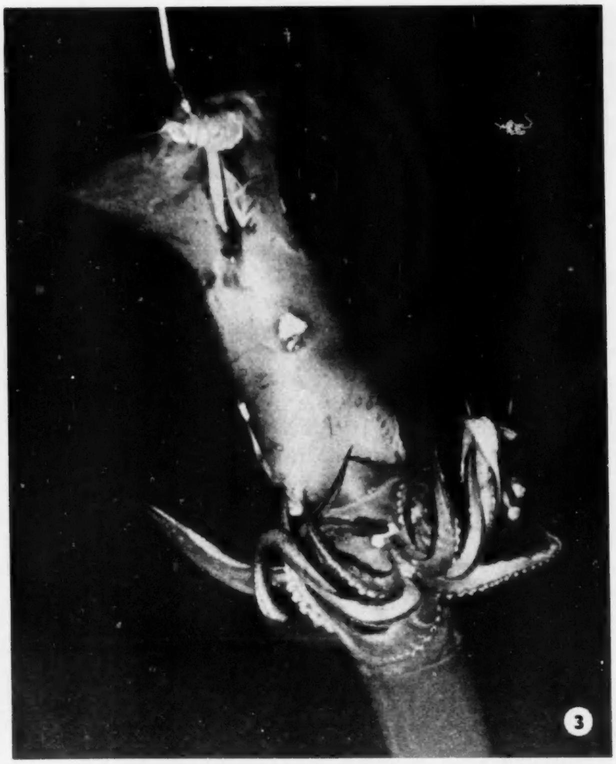
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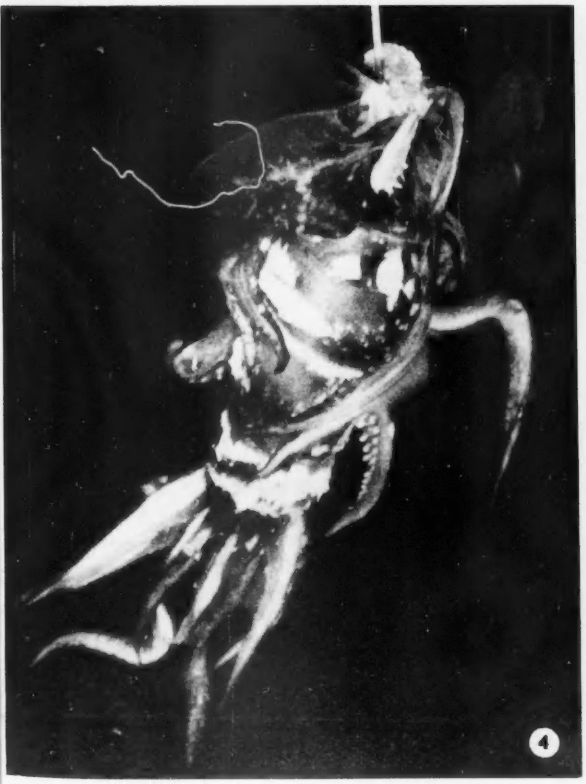
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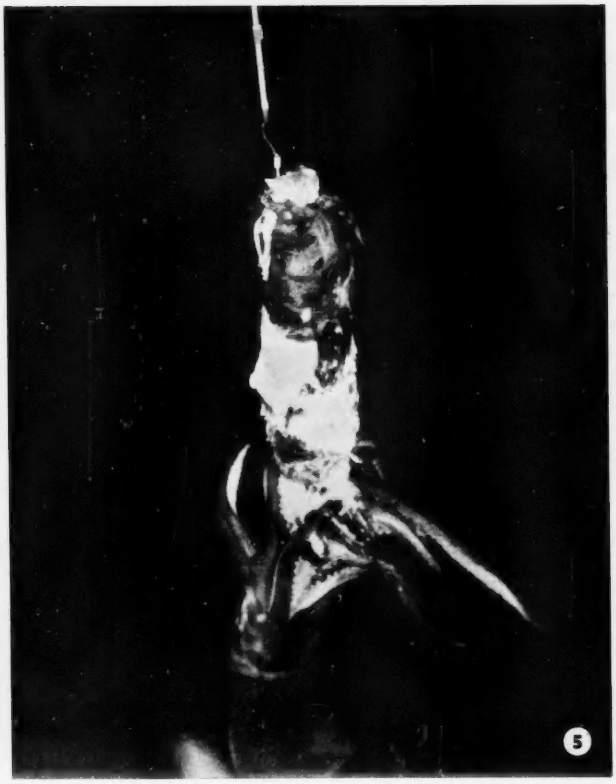
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POLAR MEDICINE

At a meeting held at the National Institute for Medical Research in Hampstead, research work accomplished in the polar regions was reviewed and the future of this type of work discussed. Over thirty people connected with polar research were present, including twenty doctors with experience in the Arctic or Antarctic, the majority of whom had been medical officers with the Falkland Islands Dependencies Survey, which, for sixteen years, has manned stations in the Graham Land Peninsula and, more recently, on the mainland of Antarctica.

The morning session was devoted to review of past work. Dr O. G. Edholm, Head of the Division of Human Physiology of the National Institute for Medical Research (which has for some years been responsible for giving guidance to prospective medical officers) was in the chair. Dr H. E. Lewis (British North Greenland Expedition, 1952–4) reviewed the recent history of British physiological research in polar regions. He pointed out how the organisation of the work had become centralised under the wing of the Division of Human Physiology. Much of the earlier work had been fragmentary, not because of lack of skill but rather, perhaps, because of lack of a central theme running through it. He pointed out how, with a continuing programme of observations, numerous polar legends had been examined and put to the test. Dr J. P. Masterton (British North Greenland Expedition, 1952–4) gave an account of how a number of casual observations and well-known facts had led to some well-instrumented experiments into energy expenditure and food intake in cold regions. From the fact that men in the cold have a high fat intake and that huskies eat human faeces, experiments and further observations led to a number of conclusions: that in spite of fat intakes of almost 300 grams per day men absorb virtually all of it, leaving the coprophagic huskies no nutritional value; that men expended very large amounts of energy, 4500–5000 calories per day, while travelling with dog-sledges, and even while at their base camp performing routine duties energy expenditure of the order of 3900 calories per day were usual. Dr A. Rogers (Trans-Antarctic Expedition, 1957–8) continued this work. Measurements confirmed earlier estimations of the very high energy output of men at base. Major J. M. Adam, who took part in the Anglo-American Physiological Expedition of 1958, suggested, from measurements made on men of the TAE during the last few days of the transcontinental journey, that although travel with vehicles was obviously less strenuous, the daily energy output actually approached that of sledging because of the longer day.

Dr L. G. C. Pugh described experiments performed in the Antarctic with the Anglo-American Physiological Expedition to measure effects of solar radiation on man. He found that in spite of the low altitude of the sun, men travelling during the summer could gain more than 300 calories/m.^{2}/hr., which would be the same as raising the ambient temperature by 10°C. The gain under desert conditions is of the order of only 240 calories/m.^{2}/hr. Dr H. T. Wyatt (FIDS) described the persistence of cold diuresis throughout a year's stay in the Antarctic, and also gave a description of trials on a new dog ration. Dr J. Graham

Typical of the working conditions in polar research. Three members of the United States Antarctic Expedition determining a safe route over the ice prior to moving their aircraft to the site of flight operations.

(FIDS), following up observations made on the BNGE and the TAE on sleep rhythm, showed that even in this remote area of the world social pressure partially determined the length of nightly sleep, that is about eight hours in twenty-four, and that when some of this pressure was released by the departure of the base leader the average nightly sleep went up to above nine hours. He could find no clear correlation between length of sleep and the previous day's work.

The afternoon discussion on the future of medical and biological research in polar regions was initiated by Sir Vivian Fuchs, Scientific Director of FIDS. He admitted, on seeing the size of the meeting, that "physiology had come to stay in the Antarctic", but pointed out that up till now it had naturally received a rather low priority. He stressed the well-known difficulty of persuading subjects to co-operate in what might sometimes be rather unpleasant experiments. The suggestion that for better results it would be advisable to have two medical men at one station was obviously sound. The meeting was heartened, too, by his suggestion that a physiological station in the Antarctic might be feasible. Many problems of cold-climate physiology could be investigated at such a station and might indeed be as useful in this field as the early high-altitude experiments in the Andes were to respiration physiology.

Sir Raymond Priestley, one of the veterans of polar exploration, suggested that since his day the psychological problems have changed considerably; where there was once complete isolation and real hardship, there was now radio and relative comfort, but there is still the problem of living in constant close contact with one another. There is much to be learnt from intelligent, discreet observation.

The discussion touched on other suitable topics for

investigation; for example, it was felt that the time had come to observe the reaction of women as well as men to the polar conditions, and that investigation into the adaptation of the local fauna would be of considerable value.

The papers and the discussions gave some hint of the interest and further possibilities for medical research in the polar regions. The medical profession ought to be no less forward in making their claim in this fascinating field of human endeavour than other scientists have been.

MESSAGES FROM SPACE

The question whether life exists elsewhere in the universe has intrigued man for a long time, and provided a fruitful source of material for the writer of science fiction. Speculation has ranged from certainty that life must exist elsewhere than on Earth to an almost equally emphatic denial, and now the general view seems to be turning once more to a highly likely answer in the affirmative. The kind of answer that is given depends, of course, on a number of factors which assume different aspects from time to time as man's scientific knowledge grows. When the telescope was first turned to astronomical use in the 17th century the Moon was seen to be a body similar to the Earth with mountains, valleys, and, it was believed, seas. As short a time as 150 years ago, William Herschel postulated that beings inhabited the Sun living, he believed, below a hot outer atmosphere. The picture gradually changed. The Moon was found to be an arid body without air or water and life on it was then taboo, in spite of the efforts of an over-zealous and highly imaginative American reporter who published details of lunar creatures supposedly observed by John Herschel who, to his eternal credit, never made any such claims and first learned of them from newspaper reports. Studies of solar physics next showed that William Herschel's hypothesis was untenable and speculation shifted to life on the nearer planets.

Mars was, and still is, the favourite although the existence of artificially constructed canals on its surface, so strongly and enthusiastically advocated by Percival Lowell in the U.S.A. never had a wide following and nowadays the theory is, like the Dodo, extinct. Of course, the 20th century has seen the advent of the "flying saucer-er" who believes that some unidentified flying objects are the space-ships of visitors from other parts of the universe whose aims and objects are the subject of interpretations ranging from the fantastic to the frankly ridiculous. There is, of course, no arguing with those who hold such beliefs. They are a tenet of faith and as such no discussion designed to show either self-inconsistencies in argument or the immensely high degree of improbability can be of any avail. The motto "faith not reason enter here" brooks no scientific analysis.

The second half of the 20th century has seen the beginning of the techniques of space research and it is, perhaps, only to be expected that a new impetus has been given to investigations of extra-terrestrial life. Recently Dr Frank Drake who has charge of the 85-ft. radio-telescope at Green Bank, Virginia, has conceived and has now begun to carry out his idea of "listening" for intelligible radio messages from other "solar" systems and, in particular, from those which he believes may be associated with the sun-like stars τ Ceti and ϵ Eridani, both of which lie some eleven light-years from the Sun. Dr Drake's proposed investigation has met with various reactions. One thing is certain, the proposals are calculated to fire the imagination of both Press and public and it is, therefore, pertinent if we consider briefly the scientific suppositions which lie behind it.

To begin with what form can extra-terrestrial life take? Certainly we can only argue from what we already know for it is clearly established that throughout the depths of the visible universe there are no chemical elements other than those of which we are already aware. In consequence we can lay down certain specifications for those conditions which evidence shows are necessary for the existence and development of the complex organic molecules of which living matter is made. In the solar system this reduces us to the planets Mars and Venus and although doubt has been cast on the suitability of Venus, we have at the best three out of nine planets on which the requisite conditions can exist.

Next, how many stars have planetary systems like that of the Sun? Observationally we "just don't know" and our answer must depend upon an assessment of the means of formation of systems of this kind. If, for example, the solar system was a freak then we should expect very few such systems to exist in our own galaxy; on the other hand if, as now seems more probable, the formation of the solar system was not an unusual occurrence then we can suppose that the number of similar systems is legion and the number of planets with conditions suitable for life also numerous.

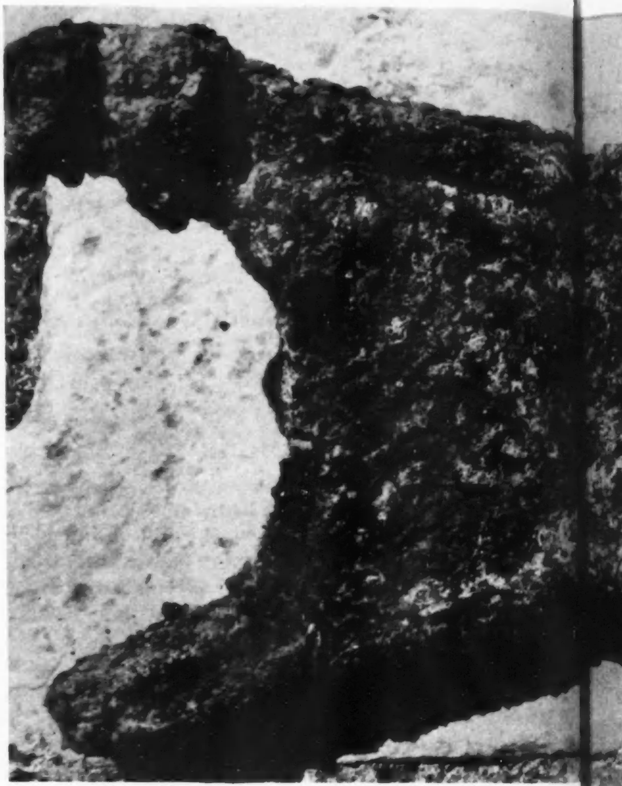
But Dr Drake's experiment depends not only upon the likelihood of the existence of life elsewhere (with the assumption that if conditions are suitable then life will begin), but also upon that life having evolved sentient beings which have developed technologically on our own lines and to a state similar to our own, with a curiosity about the universe similar to that of Man and the kind of outlook and society which will support research by transmitting radio signals of a particular wavelength. In addition these signals must, if not readily intelligible, at least show themselves not to be random series of pulses. Moreover it must be remembered that the systems which Dr Drake proposes to investigate are distant eleven light-years and, in consequence any messages picked up now must have been transmitted in 1949. If Dr Drake attempts to transmit back then it will not be until 1971 that his message is received and 1982 before he gets an answer. A celestial chess game would, therefore, become a very protracted affair!

All said and done this experiment is balanced on a knife-edge of probabilities. Even if all should be in its favour then any two-way communication, which is obviously the most interesting of the various hopes which could arise from it, will have a time factor which makes the whole thing impracticable—it would stretch anyone's imagination—even Dr Drake's—beyond its elastic limit. And, after all, who knows, the wretched beings circling round ϵ Eridani or τ Ceti may, in fact, be sitting all the time and waiting for messages from us.

TWO CARIAN WRECKS

HONOR FROST

Underwater wrecks provide a hoard of historical objects in a state of preservation almost impossible to find on land, and their investigation requires entirely new techniques.



Copper, ox-hide ingot from the Bronze Age cargo.
Photograph by Mustafa Izmir

So much publicity has been given to the "science of underwater archaeology" that it is necessary to make a few reservations before broaching the subject. Archaeology may be a science, but its concepts cannot be expressed in terms of mathematical formulae. Metallurgists, chemists, physicists, and many others are consulted in the course of an excavation, but the archaeologist's own technique eludes definition. The scientific method of excavation is associated in most people's minds with stratigraphy, but stratigraphy, though a timely corrective to former methods of dating, is not an end in itself. However, the practice of observing strata has had the effect of circumscribing and limiting the digger's aims to a predetermined trench-area. Whereas an archaeologist used to follow a drain to its source, he is now content to note its existence in his trench and leave the discovery of its origin to posterity.

VALUE OF UNDERWATER EXCAVATIONS

Accuracy of dating and recording has imposed a disciplined method of work. When the problem is the investigation of a wreck in deep water, it is apparent that an entirely new, but equivalent, technique has to be invented. Unfortunately, diving enthusiasts are quite uninhibited and to date, no archaeologist of standing has taken to the water. Indeed, archaeologists have been prejudiced by the publicity and pillage so often associated with the discovery of ancient wrecks. They have even questioned the value of underwater excavation. Why should a professional with a team of technicians spend their time on a single wreck, working under conditions so infinitely more difficult than on land? Would they not be better employed on a mound containing a dozen or more complete civilisations? The answer is that a wreck represents a hoard of historical objects in a state of preservation which it would be almost impossible to find on land. Such happy accidents (archaeologically speaking) as Pompeii and Herculaneum are rare.

So much for the importance of an individual wreck, but in the last twenty years since the invention of the aqualung, thousands of wrecks from Classical times and earlier have been located in the Mediterranean. Until now no effort, either individual or national, has been made to mark these wrecks on a chart. If this were done and the date and provenance of each ship were recorded (from the evidence of, for instance, the amphorae it carried) many problems pertaining to early trade and navigation could be solved.

With these considerations in mind, the writer has attempted to record, in particular, details of two among the many finds off the southern coast of Turkey (see cover of this issue). Having worked as an archaeological draughtsman on land, it seemed obvious that a wreck-plan was an essential preliminary to excavation. The wreck with the "Globe Amphorae" lies in deep water, on a sandy bottom, off small uninhabited islands some distance from the coast. A wreck, meaning a ship complete with timbers and cargo, can only be found in more than 25 m. of water, beyond the ravages of wind and current. If a ship falls on rock, timber is

destroyed by the animal life. Sand, on the other hand, covers whatever may fall on it and because the oxygen content is reduced in the sand itself and in the layer of water immediately above it, organic matter stands a good chance of being preserved.

On this wreck the bulk of the cargo consists of globular amphorae such as were found recently on a site in Chios and dated about A.D. 750. With careful excavation, it may be possible to trace the contents of these amphorae: those buried in the sand may still have their stoppers and some of their contents. The most significant feature of this wreck is the relationship of the pile of spare anchors carried in the prow to the kedge anchor and the galley, which was aft and to port. These key points indicate the lie of the ship and the probable position of the keel. The galley is marked by crocks and pans, roof and floor tiles (in this case lying much as they fell when the wood disintegrated); it is a familiar feature on classical as well as Byzantine wrecks.

To the west of the galley area, wood was traced, 30 cm. below the sand, and for a distance of about $1\frac{1}{2}$ m. Some 40 cm. of this wood was raised, showing it to be a timber square in section with two protected surfaces. What material, whether wood or leather, covered these surfaces, has not yet been ascertained. Between this wood and the spare anchors, a bronze tube lies loose on the surface; until it is lifted and examined, it is not possible to say whether it was used for Greek fire (as a protection against pirates) or, more prosaically, for drainage. These and many other questions pertaining to the actual structure of Byzantine ships, are raised by this wreck.

There is now every hope that these questions will be answered and that a rational method of excavation will be developed, as an expedition has been organised by Pennsylvania University Museum with the collaboration of a British archaeologist from London University Institute of Archaeology. Together with some technicians under the control of Monsieur Frédéric Dumas, the French diver and pioneer of the aqualung apparatus, it has now started work on the two Carian sites.

BRONZE AGE CARGO

The second site consists of the cargo of a Bronze Age ship coming from Cyprus around 1250 B.C. Unfortunately, this ship sank in only 32 m. of water, on a rocky bottom, in a place where the current is strong, so that the structure is not preserved. However, sand about 15 cm. deep fills the rock cavities and preserves some interesting organic matter, including about a metre of rope.

The main cargo consists of about sixteen ox-hide, copper ingots bearing the Cypriot "hallmark", and at least one bun-shaped ingot. A mould from which a similar ingot could have been cast was found by Dr. Dikaios at Engomi, and is dated in 13th century B.C., late Cypriot IIb.

Half a double-headed axe was raised; unlike the other bronze objects which, although concreted, had a fairly solid metal core, the axe looked like steatite and was friable, which points to its having a heavy alloy of tin.

Other metal objects lifted were like those of the Engomi hoard and included some pike-like agricultural implements and ploughshares, also a spatula-shaped bronze blade, 60 cm. long, which was well enough preserved to show marks of burnishing. A bar of bronze measuring 110 cm. long and 7 cm. in diameter, was wedged between rocks and joined to them by concretions.

Local sponge-divers report that they found a couple of bronze caskets near the ingots. They brought them up and prised them open on the deck of their caique, but finding they contained only "black stuff", threw them overboard. They also say they have seen two bronze "couches" in the vicinity.

Very few sherds were found. These lay in the shallow sand below some of the ingots. The most interesting was the handle of a stirrup jar with two incised crosses, one in the centre of the false neck. The crosses could be Cypro-Minoan characters. Well-preserved rope adhered to this handle. Other sherds included a small piece of Mycenean painted ware, the spout of a larger stirrup jar, the neck of a vase and part of another with a side handle. These and other small sherds were discoloured; laboratory tests have since shown this to be caused by burning and traces of carbon have also been found among the smaller fragments of metal, suggesting that the ship sank as a result of fire. Since the current is very strong, it is likely to have carried away the bulk of the pottery and only such pieces as were broken, or tied to the heavy cargo sank with it. When it is possible to make further investigations, complete vases and stirrup jars may be found, down current, lodged under shelves of rock.

THE ABOMINABLE SNOWMAN

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The evidence supporting the existence of the abominable snowman includes drawings and eye-witness accounts, but there is still room for doubt and for scientific confirmation.

While investigating Tibetan books in the library of a former lamaistic university of Gandan, Dr Vlček of the Czechoslovakian Academy of Sciences found a book by Lovsan-Yondon and Tsend-Otcher, entitled, in free translation, "Anatomical Dictionary for Recognising Various Diseases". It was a typical Tibetan book, printed from woodcuts on long narrow strips of paper. Each leaf was printed on both sides and each page was from a separately cut wooden plate. In the systematic discussion of the fauna of Tibet and adjacent regions he found on p. 24, in a group of monkeys, an illustration of a wild man. This illustration (*above*) shows a biped primate standing erect on a rock, with one arm stretched upwards. The head with the face and the whole body, except for the hands and feet proper, are covered with long hair. The illustration is realistic, only stylised according to the conception of lamaistic art.

Any improbable occurrence gives rise to speculation before a serious attempt is made to verify it, and the existence of the abominable snowman is no exception to this rule: it has provided the occasion for numerous articles, but there has been very little real critical analysis.

In this case it must be admitted that verification is difficult for two reasons. Firstly, it requires expeditions to inaccessible parts of the world, and secondly, since this is rather a thankless task, it will probably be left to those who are already convinced to take the initiative. Only the converted, who believe that the snowman really exists, would be prepared to face the hardships and the dangers of such an expedition.

For some months, a special commission of the Academy of Science in Moscow has been studying the enigma of the snowman. The members of this commission hold opposing views. Some think that the snowman probably exists, and that he may be the last surviving relic of a bygone age—a man who would not have benefited from a favourable social and technical environment. For the others, he is simply a legendary character.

Two small documentary books, prepared by the Moscow Commission, show that beliefs which have, or might have, some relation to the snowman are scattered over a very wide area. The question is to find out whether these are nothing more than beliefs. As the Commission was reluctant to omit anything, these two books[1] include all the available documentation, with the result that clearly implausible accounts are found side by side with facts which demand serious consideration.*

Among the early accounts, there are a few which are not entirely fantastic. Johann Schiltberger is apparently reliable, for on returning to Bavaria in 1427 after travelling around Asia for nearly thirty years, he quoted correctly the names of people and places. He refers to a mountain range which separates Siberia from a great desert. These mountains, which may well have been the Altai, were inhabited by "wild men" whose bodies, except for the face and hands, were entirely covered by hair. Schiltberger describes how Ediguei, the chieftain of the Golden Horde, had been given a wild man and woman as a gift, and a little later he writes: "I have been to this country, and witnessed all these events, and when I was with Tchekra, the son of the king, I saw everything with my own eyes." Tchekra is a historical figure, and Schiltberger was well

* The Italian Committee for the study of population problems is also seriously interested in snowman's enigma.[4]

placed as an observer, since after being captured by the Turks, he was himself, like the wild couple he mentions, "offered as a present" to Ediguei!

RECENT EVIDENCE

Let us now consider later evidence. There is a paper, written by Prof. Jamtsarano in 1930, which supports the Mongolian belief regarding the wild man but, apart from the deeply rooted conviction of the author, it provides no precise facts. Also, Prof. Rintchen, of Ulan Bator, Mongolia, in a more recent statement in 1958, gives no direct proof, but testifies to a tenacious belief among the aborigines. Reports from Soviet soldiers guarding the frontier in the Pamir Mountains are rather confused, but these soldiers are almost the only eye-witnesses who have supplied direct information, for in the vast majority of cases the reports are second-hand. There are, however, two remarkable exceptions.

The first comes from Dr Karapetian, of the Soviet Army Medical Corps, who found himself in the mountains of Daghestan in the Caucasus towards the end of 1941. The local police consulted him about a strange man whom they had arrested, supposing him to be an enemy agent. This man was naked—in the middle of winter! "He was", writes Dr Karapetian, "undoubtedly a man, but his chest, back and shoulders were covered with dark brown hair, whereas the inhabitants of that country have black hair. Moreover, this hair was like a bear's fur, and about two or three centimetres, in length."

The man was about 180 cm., or 6 ft. tall. His skin was dark and he had neither beard nor moustache, but fine hair covered the whole of his face. He had a large nose and a vacant expression; his face had no ape-like characteristics, however. He appeared to be incapable of speech. He took no notice of the bread and water put before him. From his excessive perspiration it was obvious that heat made him uncomfortable, and therefore the examination took place in an unheated building. Lastly, this strange being was covered from head to foot with lice which belonged to none of the three species known to exist in that part of the world. Was this man a freak individual? How did he survive, naked, in the snow? What did he live on? These questions remain unanswered. It is a pity that Dr Karapetian could not catch and preserve a few lice.

The second comes direct from China, and is supplied by Prof. Koo Wai Loo, Director of the Second History Institute in the Chinese People's Republic. This scholar acknowledges the existence of the "primitive" man of the Himalayas, but distinguishes him from the wild man of the mountains south of Shensi. This man differs physically from modern man only in his extreme hairiness. He lives in the cold mountains without clothes and, as far as we know, has no tools. One of Prof. Koo Wai Loo's statements seems to imply that this man has no knowledge of fire, nor—disturbing, if true—has he any knowledge of the spoken word.

Prof. Koo Wai Loo also states that these wild men are quite common and that before the Revolution, Chinese peasants hunted them like animals or kept them as slaves, for they could be tamed and taught to do very simple jobs. In 1954 Koo Wai Loo himself saw one of these slaves. Though the creature spoke no language, he had learnt to repeat a few Chinese words and to do rudimentary tasks.

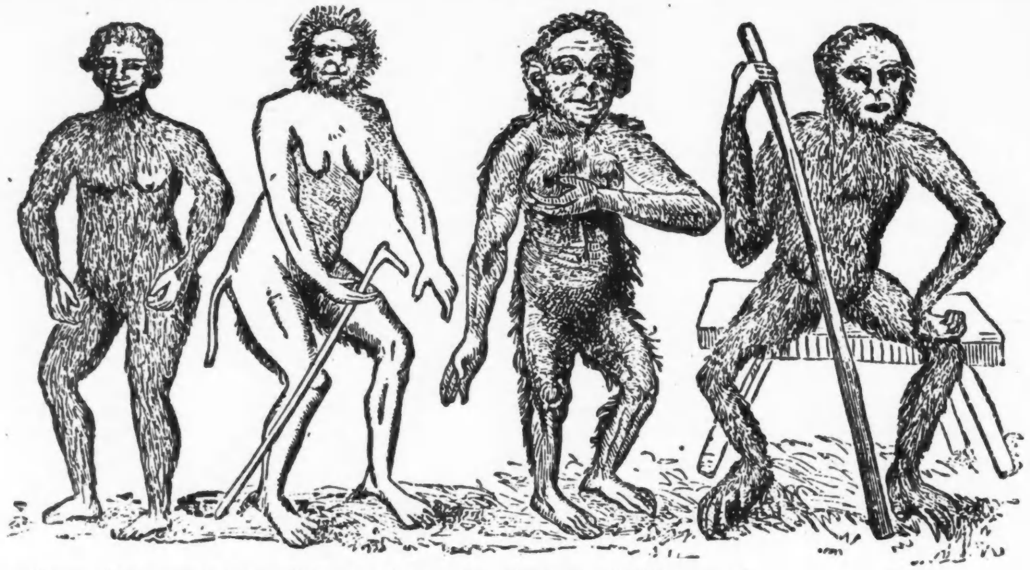
Here again the hypothesis of a pathological case might be put forward, for after all the witness saw only *one* wild man. If we accept his statement that these men are quite common and were kept as slaves by the peasants until recently, there remains the problem of identifying them. Who are these men who are perhaps not much more hairy than the Ainu (a race well known to anthropologists), but who cannot talk?

EVIDENCE FROM FOLK-LORE

The general impression received from a careful study of these two short books may be summarised as follows.

While studying the literature in the central library of the Scientific Committee in Mongolia, Dr Vlček found, in the Tibetan department, another, more recent, edition of the "Anatomical Dictionary for Recognising Various Diseases", printed a century later in Urga (now Ulan Bator). The author of this edition was Jambaldorje. An illustration of the above biped primate, along with monkeys, appears in this book also as part of a systematic discussion of Tibetan natural history on p. 119 (*right*).

(Illustrations by courtesy of Dr Vlček, Czechoslovakian Academy of Sciences)



The anthropoid apes of Linnaeus by his pupil Hoppius, "Amaenitates Academicae" (18th century).
An example of how the zoolologist wanted to represent the apes as human-like as possible.
(From T. H. Huxley, "Man's Place in Nature", J. M. Dent, London, 1960).

The domain of the snowman or wild man extends over a vast territory stretching from Mongolia to Tibet and the Caucasus. Some of the evidence provided by these books is almost certainly taken from folk-lore or legend with regard to which a certain amount of verbal similarity is noticeable. The *almass* of Mongolian legend correspond approximately to the *almassty* or *almasstyn* of Kabardino in the Caucasus. These beings, though human in appearance, are covered with fur. Since there is no linguistic link between these two countries, the geographical extension of the myth may possibly be explained by migration or borrowing. The *almaste* are also spoken of in the Pamir Mountains where another mysterious being, the *gulbiaban,* is equally well known.[2]

Further, belief in giants, athletic heroes, or wild, hairy men is very widespread, extending beyond the vast territory of Asia. We find it in Genesis, as well as in the folk stories of Western Europe. But must we assume that folk lore has no basis in reality?

A new argument in favour of the authenticity of the wild man or snowman has recently been suggested by Dr Vlček,[3] a Czech archaeologist who has been working in Mongolia. A book published in Peking at the end of the 18th century shows, among various illustrations of Tibetan fauna, a primate standing erect upon a rock. This being is called "man-animal". A more recent edition of this book, published in Mongolia, shows the same being, more humanised, and now called "wildman". Dr Vlček points out that all the other animals represented in these books are true specimens of actual fauna and not of imaginary beings. He therefore believes that "both illustrations of the wild man document, in a remarkable way, the existence of this creature." But there is, in fact, only *one* illustration, for the picture in the Mongolian edition is simply a modified reproduction of that in the Peking edition. Even the rocks on which the wild man stands are clearly copied from the original. The original picture looks like a somewhat stylised ape, it is the copy which looks more human. Dr Vlček is an archaeologist; had he been familiar with anthropological literature he would perhaps have noticed that in Europe, too, early illustrators had an irresistible tendency to humanise monkeys. T. H. Huxley once reproduced some picturesque and amusing samples of these "documentary" specimens.

Dr Vlček points out that Prof. Rintchen has collected important documentation about other people's encounters with the *almass.* This is true. But so far as I know, in spite of long and patient research, Dr Rintchen has never met any *almass* himself: once again, it is a question of second-hand evidence.

As a biometrician I have been prompted to take statistics of certain details which appear in the various descriptions. Though the figures are too small for a real statistical test, it is noticeable that in several *independent* accounts, the hair of the snowman (or his local equivalent) is described as shaded brown, brown lighted with red, or reddish brown. It is true that some other accounts describe it as grey, but again these are independent reports. It is not very much to go upon, but it may throw some light in the midst of so much uncertainty and contradiction. On the whole the documents are unconvincing, but they serve to remind us of the Okapi, which for a very long time was thought to be an imaginary animal of Congolese folk lore.

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PROPOSAL FOR AN OCEAN-GOING RESEARCH SHIP

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Small ships are no longer adequate to the widening demands of oceanographers. Large vessels must be designed which will accommodate the increase in staff and equipment, and stand up to adverse weather conditions.

The misfire of a rocket at Cape Canaveral, or the recovery of a monkey which has perforce journeyed into space, are events which receive full world coverage on radio and in the Press. On the other hand, an international oceanographic conference recently held in New York merely receives a brief mention in the more responsible newspapers (see DISCOVERY, 1960, vol. 21, No. 2, p. 54). The money spent in putting one small satellite into orbit would build, equip, and maintain at least one large research ship, probably for thirty years. One way or another man has been dependent on the sea for his livelihood for over two thousand years and will continue to be so for many years to come. Although interplanetary travel may reveal many of the secrets of the universe, bulk cargoes—at any rate on this planet—will still have to be carried by sea for a long time yet.

The oceans of the world cover an area more than twice that of the land masses, and, since economics dictate that cargo and passenger ships take the shortest practicable course between any two ports, it follows that very large areas of these oceans are virtually unexplored. Their only visitors are cable ships, whalers, a few naval vessels, and, occasionally, research ships, though there are few of these capable of extended cruises in unknown waters, and few scientists to man them.

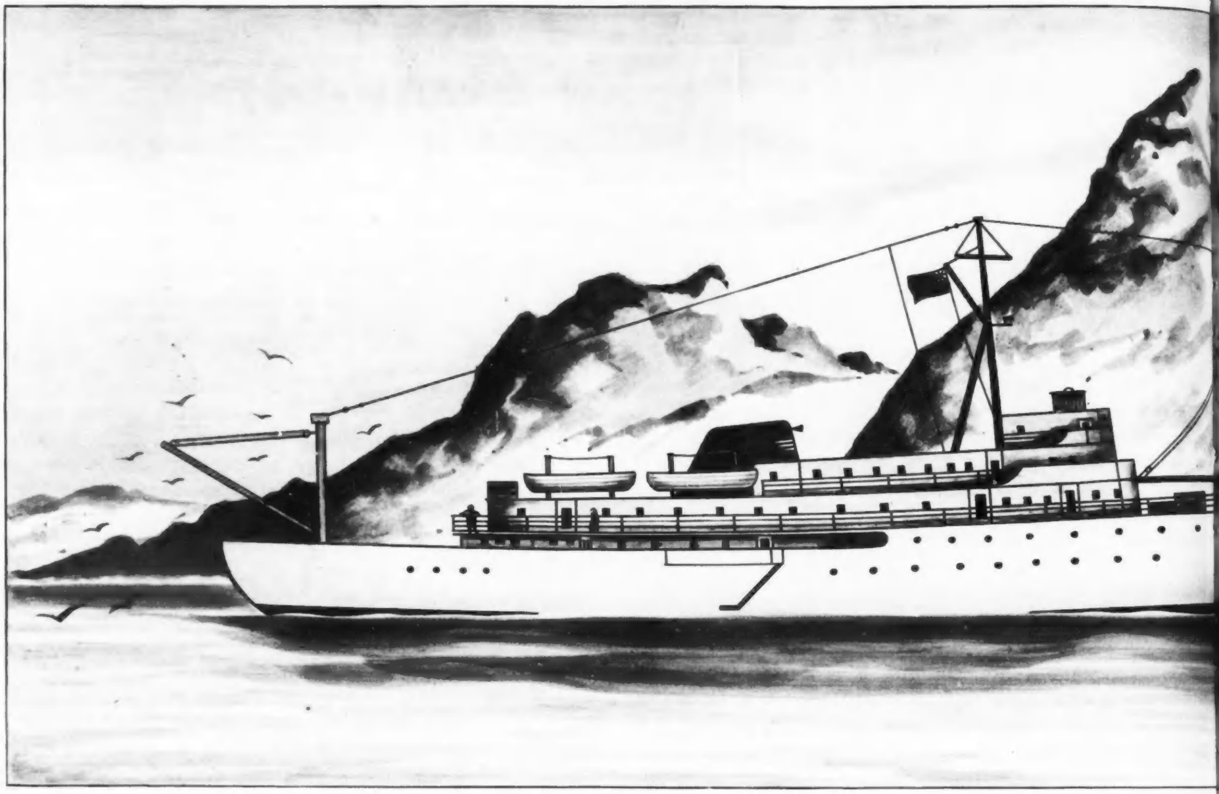
This shortage of ships and men is one of the major disadvantages under which the marine scientist works; another is the inability to see how much of the apparatus he uses behaves when it disappears below the surface. Progress is being made in the use of television, and deep-sea cine-cameras, but most deep oceanic observations, physical and biological, are made—quite literally—in the dark. Then there are the ever-changing conditions in the sea, with their as yet unpredictable variations with time and place which must be examined on an ocean-wide basis. Much has been learnt empirically of surface conditions on the trade routes of the world, especially in relation to seasonal changes, but the basic facts which govern, for example, the interaction of wind and waves, or the movement of the water masses, can only be studied in a wider field, and by trained oceanographers. It cannot be too strongly stressed that suitable research ships are a necessity, not a luxury, for this work.

All the same, progress is being made towards solving some of the fundamental problems. We now know something about the interaction of wind and sea and how waves can affect ship motion. Instruments which measure wave height are now available for ships and for the civil engineer, who can therefore plan harbour location and lay-out more economically. New current-measuring devices, which can be used at all depths, have made possible striking advances in our knowledge of oceanic circulation—on which the fish population of the world depends. This progress has not been made without encountering difficulties, and not least among these has been the difficulty of persuading sailors, engineers, and economists of the practical advantages which will accrue from this research.

MORE SPECIALISED APPROACH

The science of oceanography comprises many branches, and the advances of recent years show that a much more specialised approach to the problems concerned is necessary. This specialisation, together with the rapid increase in the use of electronics, demands not only a large and highly trained scientific staff to use and maintain the apparatus but more space in which to house personnel and equipment. Twenty years ago physical oceanography was a relatively simple science, mainly confined to routine sampling of the oceans and conventional methods of analysis. It has now developed into marine physics which, in addition to the conventional sampling still required in unexplored seas, includes the examination of the ocean floor with precision depth-recorders and coring-tubes, bottom photography, the use of free-floating current-measuring instruments, the study of the interaction of wind and sea, and the effect of waves on ship motion. All this means more space for instruments, let alone staff to run them, and if we add an electronic fish-detector and bottom-scanner, the demand for laboratory and instrument space alone is more than can be met in a small ship.

Marine biology has also, though in a smaller way, added to the complexity of instrumentation. Living animals can now be photographed at any depth, and instruments have been developed which not only measure the volume of water flowing through a plankton net but record instantaneously on deck the depth at which the net is fishing. Marine life depends largely on the fertility of the oceans, and the study of this, which includes the carbon-14 method of measuring the rate of photosynthesis, requires a considerable set-up of apparatus. On the whole, the demand for space for instruments is considerably less than the needs of the physicists, with the exception of the marine physiologist, who now relies largely on elaborate electronic equipment.



This increase in instrumentation leads, naturally, to a demand for more laboratory space in a research ship, and, because of the complexity of much of the apparatus, more room is needed for staff to maintain and use the equipment. Add present-day requirements of the Ministry of Transport for the accommodation of crew in an ocean-going ship and it will be realised that a reasonably large vessel will be needed if well-sited laboratories and adequate spaces for handling complicated and delicate apparatus are to be provided. For short cruises some form of compromise can usually be made, but when long-range research is contemplated, all branches of oceanography must be represented and proper facilities given to each. Few research ships exist which meet this need, mostly because they are too small for both the marine physicist and the biologist to work together on common problems. Far too often are small ships equipped primarily for only one branch of oceanography and the smallest research ships are seldom more than collecting agents, at short range, for a shore laboratory.

Oceanography, as its name implies, is a science to be studied mainly in the oceans of the world. Much experimental work on new apparatus and new methods can be done off-shore, but only with a long-range research ship can oceanic conditions properly be studied. Such an investigation is the international survey planned in the near future for the Indian Ocean, but the ships capable of the long traverses across this ocean are few—with the exception of those of the Soviet Union. There are now three long-range Russian research ships—all of about 6000 tons displacement, and two more are being built. Otherwise, the only long-range research vessel capable of working in the tropics or even sub-tropical waters is the U.S. *Chain*, of 1975 tons displacement. The RRS *Discovery II*, of 2100 tons displacement, now thirty years old, is certainly a long-range ship, but she is not air-conditioned and has neither sufficient laboratory space nor the accommodation necessary for a large scientific staff, such as would be needed on this project. Hence, many ships taking part in this Indian Ocean survey will be small and will have to work far from their normal base—thus severely curtailing their activities. They will all make valuable contributions towards the work, but the problem of fitting together afterwards results obtained in this way would probably be easier if a much smaller number of large ships did the work.

It is evident that the Soviet Union has realised the need for larger research ships, but few laboratories or institutions in other countries would be able to send so many scientists and technicians to sea at one time. The number of experiments or measurements which a research ship working in company with other ships, can undertake at any one time is, to a certain extent, limited, partly by the nature of the work and partly by the programme which must be drawn up so all can contribute. We might wonder, therefore, if a very large scientific staff (the Soviet ships can carry at least fifty) is justified, although there is much to be said in favour of analysing data on the spot and evaluat-

An artist's impression of what a modern British research ship may well look like. It will follow in the tradition of *Discovery I* and *Discovery II* and will embody all the latest scientific knowledge and equipment.

ing results as the cruise proceeds. Nevertheless, a large ship will be a relatively stable platform from which to work, and much can be done as a routine which would not usually be possible in a smaller ship. In other words, the larger ship can be working in weather which would force a smaller ship to heave to and the smallest research ship to find shelter.

In modern navigational methods, bridge control of diesel or diesel-electric propelling machinery is now an accepted practice. Additional bridge equipment would be required if an Active rudder or a Voith-Schneider propeller is installed to assist manoeuvrability.

ASSESSING COST AND SIZE

Meeting present-day needs for a comprehensive research ship while avoiding excessive costs is not an easy task, and much thought has been given to the subject both in this country and in the United States of America. Opinions differ on many points, especially on the question of size, but there is complete agreement that there must be a considerable increase in the space needed by the scientist. Since this increase cannot, at any rate in this country, be made at the expense of the accommodation, either of crew—or scientist—the larger ship becomes a necessity. The cost of such a ship will not be small but, with an expectation of useful life approaching thirty years, it will not be excessive. There is also some doubt whether the higher freeboard associated with the increase in tonnage would hinder the use of certain types of overside apparatus much used. Such equipment, however, appears to be used successfully in the large Soviet ships, although their tonnage seems rather large for economical operation. The American upper limit (about 1000 tons displacement) seems, on the other hand, rather small for a comprehensive long-range ship. One cafeteria mess for all on board, and an almost inexhaustible supply of student labour, housed in a large bunk-room, are factors which contribute greatly towards a smaller ship, and the substitution of student labour for professional seamen enables it to be said that the ratio of scientists to crew is 50 : 50. If this ratio had to be maintained by highly qualified scientists and good technicians, then a number of them would be wasting their time on crew duties which, in any case, would almost certainly be more efficiently done by professional seamen. However, there are not many countries which can produce such a number of students, and a ratio of fifteen scientists and technicians to forty crew is probably a reasonable complement outside the U.S.A. and the U.S.S.R.

Undoubtedly a small research ship will be more economical to operate, but her useful time at sea will depend much more on weather conditions than would a larger ship. Two or more small ships would also be needed to do with difficulty what one large ship can do easily, while requiring fewer scientists. Also, conditions of working and living would be less unpleasant and the laboratories less cramped for space. The larger ship, as has so often been proved in the *Discovery II*, can remain on the spot, hove to in reasonable comfort, when the weather worsens, and be ready to start work again as soon as an improvement sets in.

DESIGN AND DIMENSIONS

The field of marine research is now so large that it embraces the oceans of the world; it embodies many subjects, and in the past decade our knowledge of the sea has expanded very greatly. This expansion is not purely academic; it has or will have in most instances a practical application, but further problems continue to arise and future expansion in this country is hampered by lack of a really modern long-range ship capable of undertaking all types of deep-sea research on an oceanic basis. To design a comprehensive ship to serve all branches of oceanography is not easy and a balance must be preserved between marine physics and biology. Unless a very large ship is contemplated—and costs alone forbid this in Great Britain—there must, as already said, be some form of compromise. In other words, the ship should not be fitted out to cater, say, for the examination of the sea-bed alone, to the inconvenience or even exclusion of other branches of oceanography. Reasonable demands for each can easily be met, within the limits of size now proposed, which are, briefly: length (over-all) 260 ft., beam 42 ft., and a displacement tonnage of about 3000. Moulded depth would be 18 ft. 6 in., with a draught of 17 ft. The hull form of such a vessel would require very careful design, with perhaps more than normal emphasis on sea-kindliness. The advance in instrumentation in recent years makes it necessary to provide not only a stable working "platform" in fine weather, but to ensure that apparatus can be handled over side in any

weather short of a gale. As speed is not a primary consideration for a long-range research ship, hull lines do not need to be particularly fine, nor would it be necessary to consider a design to satisfy the requirement of the highest class for ice navigation. A more conventional hull form should be possible, and this alone should provide a reasonably stable ship when working deep-sea apparatus on "station". The cost of fitting fin stabilisers, which would only be operative when the ship is under way, would not be justified, and it is probable that heeling tanks would be too sluggish in their action to be of much value when the ship is stopped or hove to. Tank tests on a model of the proposed hull would not only be an advantage; they might reasonably be considered a necessity.

Since the ship in which he works is the oceanographer's major tool, it must have an ocean-wide range; it must be able to work in out-of-the-way parts of the world without the necessity to re-fuel or re-store at frequent intervals, and it must be capable of undertaking all running repairs to the ship and its machinery. The ability to steam some 15,000 miles on one fuelling, and to stay at sea for periods of four to six weeks are not excessive demands.

The method of propulsion of a research ship is a major problem of design and one on which it is not easy to reach agreement. The really important requirements are: absence of vibration and noise, the ability to steam at very slow speeds and yet preserve manoeuvrability, low running costs, and machinery which is economical of space. A type of propulsion by which the speed of the ship can be controlled from the bridge, as well as from the engine-room, is also very necessary. Various types of machinery are available, ranging from a triple expansion steam-engine to gas-turbines, though the use of the latter in ships is not yet fully developed. The most economical form of propulsion, both in space and fuel consumption, is that which uses a diesel engine as the prime mover. Straight diesel drive, however, has, for a research ship, the great disadvantage that the engine is not capable of slow running, though this can be overcome by the use of a variable-pitch propeller —at any rate in smaller ships. A more satisfactory solution, perhaps, is to use the diesel engine to drive a generator and to drive the ship by an electric motor. This is a well established method, lending itself not only to the attainment of low speeds but also to full bridge control of the engines.

There remain, of course, the question of vibration and noise which effects were, until fairly recently, almost inseparable from a diesel-engined ship. Now, as the result of much research, engine vibration has been so reduced that, certainly so far as the smaller medium-speed marine engines are concerned, it is negligible. A solution to the problem of reducing noise has not been so easy to find, but the use of modern sound-proofing and sound-absorbing materials in the engine-room makes it possible not only to confine the noise in this compartment but to reduce it to a reasonable level.

Another advantage of diesel-electric propulsion is the ready availability of current for driving, trawling, and other heavy winches. In the use of her machinery, a research ship is very similar to a distant water trawler in that the heavy-duty trawl winch is not being used when the vessel is steaming normally, and vice versa. Thus, if the winch is electrically powered, as is now usual, there is ample current available for it from the main engine generator. The ability to generate sufficient power for all needs, not only now but in the foreseeable future, is one of the most important requirements in a research ship. The difference, not only between pre- and post-war oceanographic apparatus but of the advances in electronic instruments for navigation, has nearly trebled the consumption of current in the *Discovery II*. This rate of increase is not likely to be sustained, but any modern research ship should have a reserve of power equal to her designed normal output.

Since a research ship must be able to manoeuvre easily and quickly, there is much to be said for twin-screw propulsion. Unfortunately, there are serious objections to this on several grounds. In the first instance, much biological gear, especially towed nets, must be worked over the stern, in close proximity to the rudder and propeller, and if twin screws are fitted these would project too far to each side for the safety of the nets. Secondly, they are distinctly a danger if navigation in any form of pack ice is contemplated; and, lastly, duplication of the main engines would undoubtedly mean a larger consumption of fuel. The manoeuvrability of the ship could, however, be much improved if some type of bow propeller was to be fitted, working in a duct in the bows.

LABORATORIES AND OTHER SPACES

The siting of laboratories and ancillary spaces for scientific activity in a ship is a considerable problem for the designer. They should, preferably, be amidships in the zone of least motion, have adequate natural lighting, and be easy of access to the decks without, in most instances, opening directly on to them. Generally a larger number of smaller laboratories is to be preferred, as large, common spaces are an inducement to one party to encroach on space needed by others. In these days of specialisation it is desirable, though not always very practicable, except in large ships, such as those used by the U.S.S.R., to give each branch of oceanography separate laboratories.

For a ship of the dimensions already quoted, a reasonable allocation of space for laboratories, workshops, and other scientific rooms, other than hold space, would be approximately 2400 sq. ft. In a vessel with four working decks, this might be apportioned as follows. *Boat Deck:* plotting and control-room (to house echo-sounding recorders and repeaters from all navigational instruments), and space to secure a small portable laboratory, with facilities for connexion to all main services. *Fo'c'sle Deck:* scientific library and writing-room, oceanographic deck laboratory (deep-sea water-bottles, thermometers, and so forth), a large general laboratory for marine biology and chemical analysis of sea-water, and an electronics laboratory (which should also include simple workshop facilities). On this deck there should be a ready-use scientific store and a small office for the resident scientific assistant. *Shelter Deck:* at the after end of the accommodation on this deck would be the netman's workshop and store and general scientific workshop, on one side, and a rough or

"wet" laboratory on the other—with the heavy-duty trawling and dredging winch amidships between them. A small battery-room should be sited here with leads to the main laboratories on the deck above. *Upper Deck:* here would be situated the photographic room (with adjacent dark-room), a low-temperature biological laboratory (adjacent to the ship's main refrigerator), and an under-water instrument room. This space would house the electronics of the shipborne wave-recorder and electrical and other apparatus associated with Asdic, or similar equipment. Below this room, and with the top above the load water-line, would be, it is hoped, a trunk through which transducers and other apparatus could be lowered directly into the sea below the hull. In addition to all the above, there should be sufficient hold space, preferably aft, for storing bulky equipment, specimens, and reserve stocks of all consumable scientific stores.

All laboratory doors, and doors giving access to the deck near them, should be as large as is practicable. Much modern apparatus is bulky and it is a very time-consuming job if experimental equipment has to be dismantled both on arrival and departure. Laboratories, too, should have as much natural light as possible—and preferably by large windows at bench-level.

A small magazine, below the water-line, and probably in the forehold, would be required for storing the explosive charges used in geophysical experiments relating to the structure of the ocean floor.

The principal requirements on deck in a comprehensive research ship are adequate space and the ability to handle vastly differing types of equipment, some of it bulky and often unconventional in shape. Masts and derrick-posts should be self-supporting—that is, without stays to the ship's side, and where one deck overhangs another, such as in way of the bridge wings, the overhang of the deck should be supported on the cantilever principle. Stanchions—in way of the bulwarks—are a serious hindrance when long and often unwieldy apparatus has to be brought on board.

A large clear deck-space aft is necessary if trawls and deep towed nets are to be handled easily, and derrick-posts should not be sited on the middle line—nor should the hatch to the after hold. Forward, space is required for handling coring-tubes, perhaps 60 or 70 ft. long, with the necessary lifting arrangements by derricks—again off the centre line. Modified trawl-gallows would be needed on either side after for use with mid-water trawls. Throughout the ship all heavy blocks, measuring-sheaves, stern roller, and trawling fairleads must have roller bearings. Fitted thus, wear on moving parts is negligible and maintenance is reduced to a minimum. Shock-absorbing equipment, to prevent sudden jerks on deep water-bottle and other wires should be fitted wherever possible. Adequate lighting of all working parts of the deck, both fore and aft, is imperative.

OTHER EQUIPMENT

Apart from the winches associated with the derricks, which would be to a standard design, all other deck winches in a research ship are of special design. For coring in the sea-bed or for trawling and dredging, two winches, of approximately the same horse-power (75–100) would be needed. The coring winch, with one reel, storing some 10,000–12,000 m. of a tapered wire rope, would be fitted forward. The trawl winch, aft, should have three drums, a centre one storing about 12,000 m. of tapered warp and two similar drums with shorter warps for mid-water trawling. Both winches would be electrically powered. For lowering small sampling and similar instruments, such as water-bottles, and small plankton-nets vertically into the ocean, three small winches of approximately 10–12 h.p. each are necessary. One of these (for water-bottles) would store 10,000 m. of wire cord, another, 5000 m. of a slightly heavier wire cord for vertical nets, and so forth, while the remaining winch should have two drums, one to take the fine wire cord used for mooring deep-sea marker-buoys, the other a considerable length of a cored conductor cable. A powered reel for handling and storing a long length of small-diameter nylon rope is a possible need, as is a small winch for coring in very shallow water.

Navigational and communication equipment should include deep and shallow echo-sounders (in addition to the precision depth-sounder recording in the scientific plotting-room), radar (with true-motion plot), Loran, Decca navigator and plot, an electric log, and a gyro compass with course- and distance-recorders (one of these would record in the scientific plot). Repeaters from the gyro compass would be fitted in laboratories and elsewhere as necessary.

Other bridge equipment should include clear-view screens in the wheelhouse, bridge control of the main propulsion motor, helm and main engine revolution indicators and a heeling indicator. Some form of a "talk-back" communication system to essential parts of the ship would be controlled from the wheelhouse.

World-range radio equipment, and radio telephony, are necessary requirements for external communications; internally, a telephone system connecting all major points would be needed. Whether or not sound-reproduction equipment should be fitted in all messes and similar spaces is a debatable point.

Single-berth cabins throughout, to the latest Ministry of Transport standards, would house all crew except boys. The standard of accommodation for scientists should be equal to that of the ship's officers, and, as a general rule, the segregation of either is to be deprecated.

Since a long-range ship is envisaged, space should be found for a combined library and cinema; this may well be sited on a lower deck unsuitable for living accommodation.

To sum up—the design of a comprehensive oceanic research ship is a complex matter—with little in the way of existing vessels to act as a guide to the designer. So far as the ship herself is concerned the present-day naval architect is very conscious of the help science can give in design, but neither he, nor the scientist, can really foresee the rate of advance of a young science such as oceanography. The best that can be done is to provide the ship with an apparently more than adequate reserve of electric power, sufficient space for reasonable expansion, and hope that both seaman and scientist will prove as adaptable to progress in the future, as they have been in the past.

MALARIA THE KILLER

J. L. CLOUDSLEY-THOMPSON, M.A., Ph.D., F.L.S.

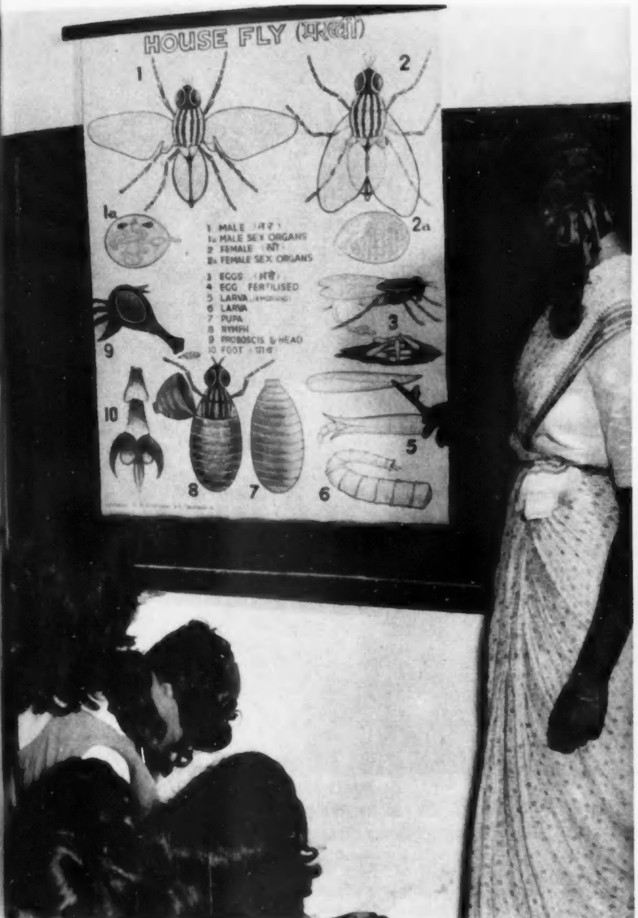
In 1953 two-thirds of the population of India alone suffered from malaria. Since then the World Health Organisation has reduced the world mortality rate of three to four million, but there are still one and a half million lives to be saved each year.

Throughout the world, more people die from diseases transmitted by the bites of mosquitoes than from any other cause, and malaria is unquestionably foremost of these diseases. Until a few years ago, a quarter of the population of the globe, if not more, suffered from it at one time or another, and, in India alone, more than a million people died annually. Moreover, these were not the only victims, for the malarial parasite undermines the health of those it infects, making them weak, listless, and very susceptible to other diseases which may well terminate their wretched lives.

SOCIAL PARADOX

The problem is a complex social one. Where conditions are bad, malnutrition makes people more vulnerable to malaria, and this, in turn, weakens their physique, so that they can earn even less than before. In many parts of the world a high proportion of the population is still incapacitated for several months every year. On the other hand, where malaria is reduced by mosquito control, the resulting population increase results in even greater food shortage.

Until five years ago, India, with a population of some



MALARIA IN INDIA

FIG. 2 (*above*). Following an order from the Indian Ministry of Health, schools throughout the country incorporated lessons in parasitology in their weekly schedule. Here young girls attending a school in the State of Berar (Central India) follow a lesson on the stages of reproduction of the house fly. Similar lessons are given about the malaria-carrying mosquito.

Pierre Pittet

MALARIA IN INDIA

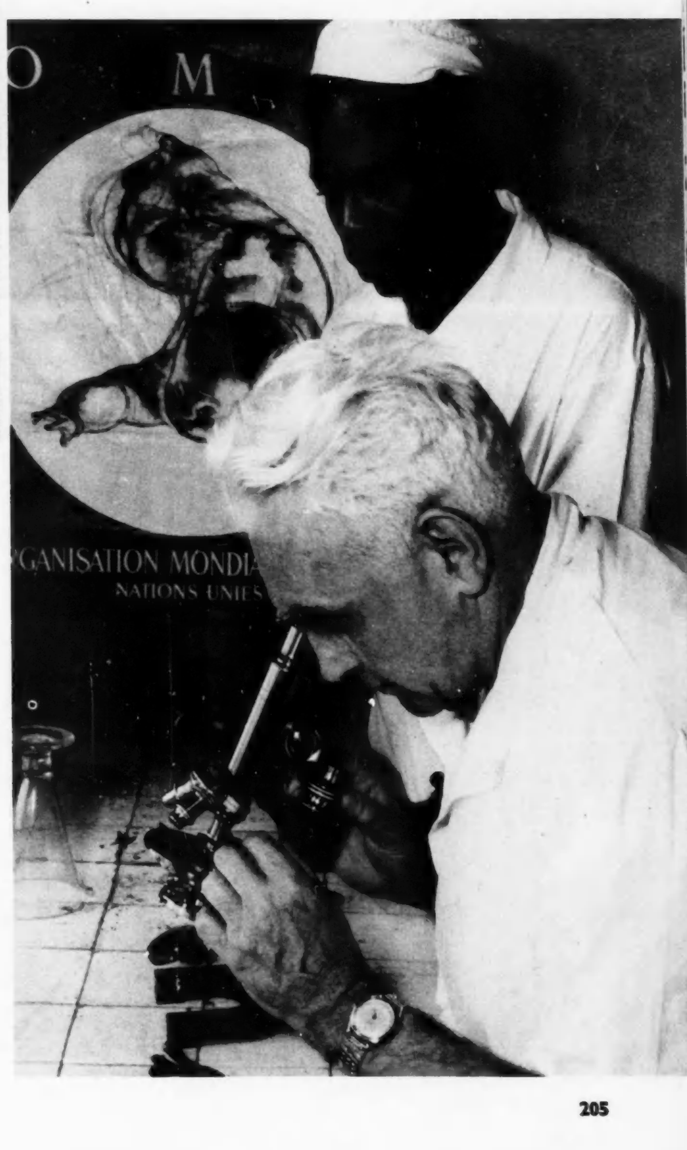
FIG. 1 (*left*). Malaria strikes an estimated 300 million each year, about 3 million of whom die. This woman lying in the open with a fever attack, was brought to the WHO anti-malaria team in the Terai Region in the foothills of the Himalayas, India, for treatment.

(All photographs are by courtesy of WHO Geneva. Where the individual photographer is known his name is given.)

MALARIA IN THE FRENCH CAMEROONS

FIG. 3 (*below*). A WHO expert can only spend a limited period on any one project. Training local staff is therefore one of the main tasks if projects initiated by international personnel are to continue and health work is to reach all the people. Prof. Morin, Chief of WHO's anti-malaria pilot project at Yaoundé, French Cameroons, Africa, trains local assistant in all phases of anti-malarial work.

Pierre Pittet



MALARIA IN TRINIDAD

FIG. 4 (*above*). During the first three quarters of 1955, malaria claimed 32 lives in Trinidad: in 1945, the malaria death toll was over 400. In the main, malaria eradication in Trinidad requires the annihilation of the *Anopheles bellator* mosquito, which breeds in the reservoirs of water which form among the thick, spike-like leaves of bromeliads—a plant which looks like a pine-apple and grows on the trunk and limbs of trees. Of the 57 species of bromeliads known to flourish in Trinidad, the *Aquilegia gravisia*, which grows specifically on Immortelle trees, is known to be the most troublesome of the hosts of the *Anopheles bellator* mosquito. Here, members of a malaria eradication gang clear the river-mouth at Maracas Bay to allow proper fluctuation of water to prevent breeding of *A. aquasalis*. Note stagnant water in right foreground.

Maxine Rude

MALARIA IN NEW GUINEA

FIG. 5 (*left*). Almost 100% of the children born in the lowlands are affected by the disease. If they survive their first year, their average life expectancy is still not higher than twenty.

350 million, had at least 200 million cases of malaria per year, of which only 8 to 10 million were treated. The direct mortality from the disease may be as low as from 1% to 2%, but it accounted for a sizeable death-roll. According to World Health Organisation statistics, about 250 million people there had clinical attacks of malaria each year, of which some 17 million received treatment. The world total of humans infected by the malarial parasite in 1953 was in the region of 350 million.

Although primarily a tropical disease, malaria also occurs in temperate regions. In the United States, some 250,000 cases were reported annually in the last decade, and malaria was endemic in the British Isles until quite recently. During the years 1852–9, between eighteen and fifty of every thousand patients admitted into St Thomas's Hospital, London, were suffering from the disease.

During World War I the British Army suffered little from tropical diseases until an epidemic of malaria began in Salonika, where it continued until the cessation of hostilities. Altogether there were 30,059 hospital cases from Salonika in 1916, 71,413 in 1917, and 59,087 in 1918. During 1918 two whole divisions were withdrawn and treated with quinine in France, and large malaria treatment camps were also established in England. Infected troops reintroduced the disease into the Fen district of East Anglia, where it had been endemic until recent times, and now fewer than 235 indigenous cases were reported in 1917, falling to four in 1924.

FINDING THE SOURCE

It has long been known that the disease is most widespread in marshy regions where the water is brackish, hence the name "malaria", which means "bad air". Other names, such as "paludism", also reflect this relationship of the disease with swamps, but it was not until the work of Sir Ronald Ross that the true association with the mosquito was appreciated, although in one African tribe the name for "malaria" and the word meaning "mosquito" are the same.

Perhaps the only thing to be said on behalf of malaria, from the human point of view, is that it has been used in therapy. After missionaries had noted that in malarious districts syphilis does not always result in general paralysis of the insane, controlled inoculation of the malarial parasite did result in considerable improvements in the condition of patients.

The claim that malaria was largely responsible for the downfall of the Roman Empire is probably exaggerated. No doubt malaria played a part, but other epidemic diseases were also important as well as various moral and economic factors.

Since 1953, the incidence of malaria in the world has dropped from 350 to 150 million and direct mortality from 3 to 4 million to 1½ million. This change is associated not with any marked improvement in the standard of living but with the revolution in insecticides that has taken place since the end of the war. The development of residual insecticides effective for periods of up to six months has resulted in the emphasis of control measures being directed against mosquitoes entering human dwellings whereas

MALARIA IN IRAN

FIG. 6 (*above*). Members of the WHO malaria team working at night at the Kaseroon hospital on specimens collected during the day. WHO is assisting in a seven-year malaria eradication programme in Iran which will eliminate the disease from 12 million people living in 14,000 villages.

MALARIA IN TANGANYIKA

FIG. 7 (*below*). An assistant collects *Anopheles* from cages built at the edge of the kraal. The *Anopheles* caught in glass tubes, are then transported to the laboratory built in the Mount Pare plain by the East African Malaria Institute.

Dr Holstein

previously it had been directed against larvae in their breeding-places.

Although these successes give grounds for optimism, it must be tempered by the thought that the governments of many of the more underdeveloped countries have yet to be convinced of the efficacy of positive malarial control measures. Although attempts are now being made to eradicate malaria in regions where previously it was kept under

MALARIA IN IRAQ

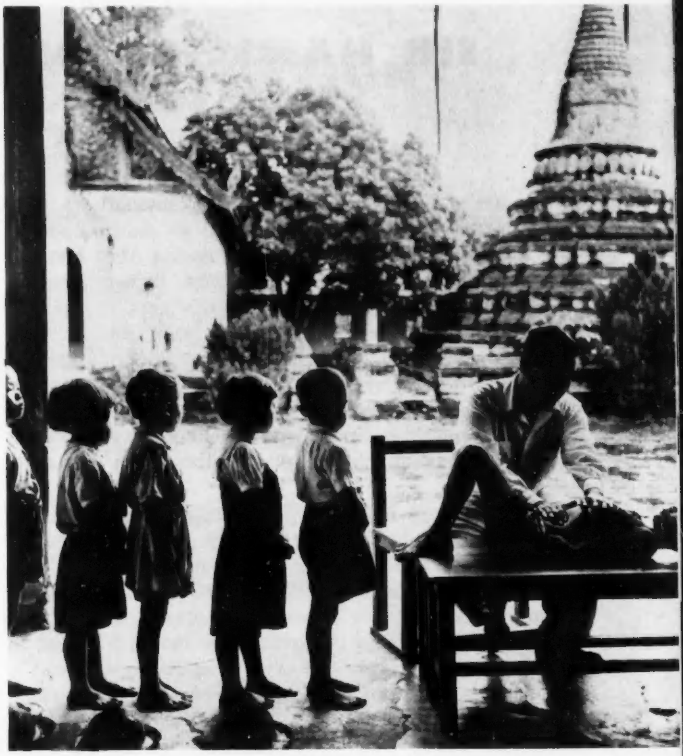
FIG. 8 (*left*). In Northern Iraq, malaria is hyperendemic, killing one out of five infants, and in some parts infecting 80% of all infants. Expectant mothers journey for miles to give birth in non-infected villages where their babies have a better chance of survival. Here an Iraq laboratory technician checks a wall scraping against a colour chart to determine the deposit of insecticide.

MALARIA IN MEXICO

FIG. 10 (*right*). Mexico, which has decided to eradicate malaria and deliver its 30 million inhabitants from the disease which has crippled empires and destroyed civilisations, has been put on a war footing. High-ranking officers direct the campaign from an operational headquarters from which they deploy spray teams as though they were combat troops. After spraying, the huts are carefully checked to see that all the mosquitoes' hiding-places have been covered with the insecticide. When this check has been made, squad leaders tack signs on to the walls of each house.

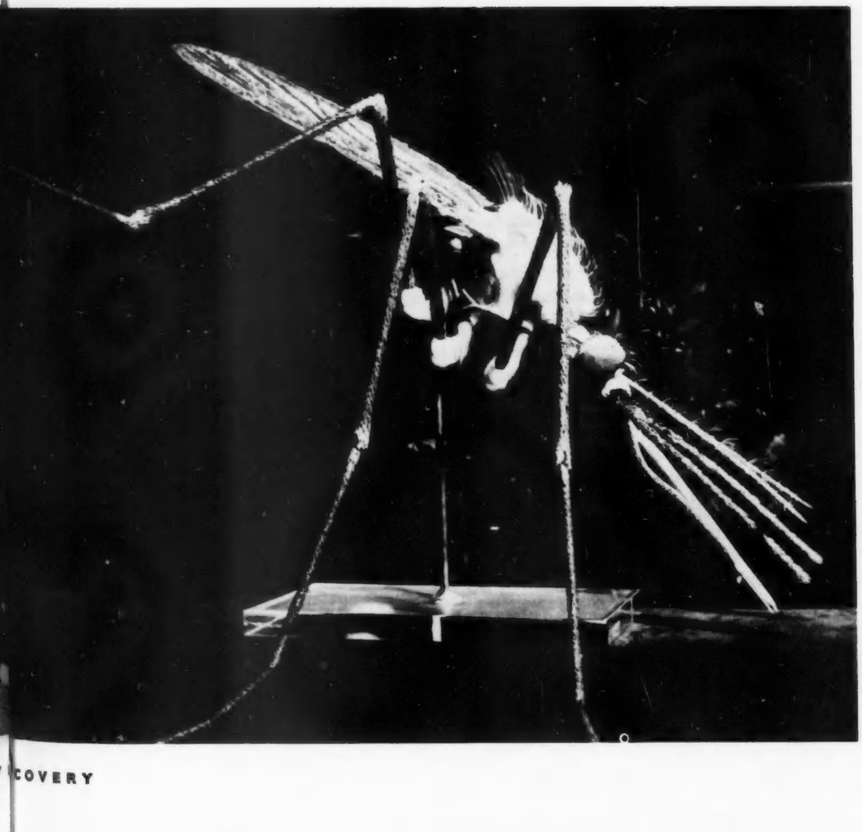
Eric Schwab

control only by the continuous use of insecticides, the disease still broods over much of the tropical and sub-tropical world and is especially menacing in central Africa. Furthermore, the battle is not static: at the present moment there is a critical race between the elimination of the disease, if not of the anopheline mosquitoes which transmit it, and the development of resistant strains of the insects.



MALARIA IN THAILAND

FIG. 9 (*right*). One of the ways of determining the incidence of malaria is to examine schoolchildren for enlarged spleens, which are a symptom of the disease. Here Dr Udon, the Thai member of the WHO Malaria Control Team, examines spleens on the steps of the Temple of the Reclining Buddha, near Chiengmai, North Thailand.

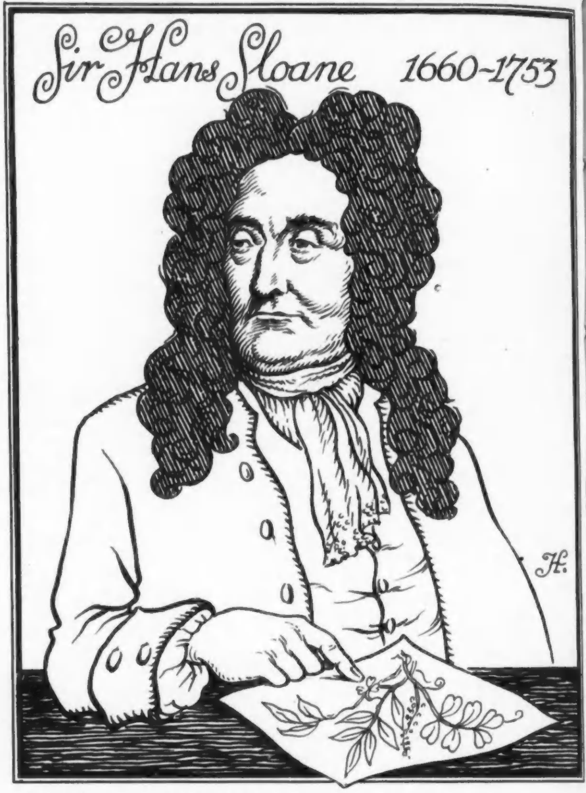


MALARIA IN COLOMBO

FIG. 11 (*left*). The discovery of insecticides such as DDT has made it possible to destroy the malaria-carrying mosquito, but it has been found that certain species could become resistant to DDT and to Dieldrin. In other words, these insecticides were no longer deadly to the mosquito. It was the threat of this resistance to insecticides becoming widespread that led the eighty-eight Member States of WHO to decide in 1955 to launch a world-wide malaria eradication campaign.

SIR HANS SLOANE, Bart., M.D.

1660–1753



Specially drawn for DISCOVERY by J. F. Horrabin

The name of Sir Hans Sloane, the tercentenary of whose birth occurs on April 16, is known to most Londoners through the Chelsea thoroughfares named after him, and to some by the Sloane MSS in the British Museum. Generally remembered as a collector, he contributed in other ways to the advancement of science. Born at Killeleagh, Northern Ireland, Sloane was of Scots extraction. His natural history studies began at an early age, but when only sixteen he suffered a severe illness with spitting of blood. Although he experienced similar attacks throughout his life the regimen he adopted enabled him to reach a great age.

In 1679 Sloane had recovered sufficiently to proceed to London to study medicine. After taking lessons in chemistry, and botanizing at the Apothecaries' Garden at Chelsea, he continued his studies at Paris and Montpellier, attending Tournefort's lectures in botany, and those of Duverney in anatomy. He returned home an M.D. of the University of Orange, and with a good background of medical and botanical knowledge. Within a short while he was elected a Fellow of the Royal Society, and made the acquaintance of Thomas Sydenham, the "English Hippocrates", who took him into his house and gave him valuable instruction.

In 1687 Sloane's love of botany prompted him to go to Jamaica as a physician to the Governor, the Duke of Albemarle. He brought home various specimens of the animal kingdom and no less than eight hundred different species of plants. In 1696 he published his "Catalogus Plantarum", a work in which he had taken extraordinary care to avoid duplicating the work of others, having referred to the writings of every traveller of note.

Appointed Secretary to the Royal Society in 1693, he revived the printing of the *Transactions,* which had lapsed. Sloane became M.D. Oxford in 1701, and in 1707 published the first volume of "A Voyage to the Islands of Madera, Barbadoes, Nieves, St Christopher's, and Jamaica, with the Natural History of the Herbs and Trees, four-footed Beasts, Fishes, Birds, Insects, Reptiles, &c." The labour involved delayed the appearance of the second volume until 1725. The first volume greatly enhanced Sloane's reputation, and in 1708 he was elected to a vacant seat among the few allotted to foreign members by the French Academy of Sciences. He was elected Vice-President of the Royal Society in 1712, and in 1727 succeeded Newton as President.

Highly successful in his profession, he was consulted by Queen Anne, and on the accession of George I was appointed physician to the Army. Physician to Christ's Hospital from 1694 to 1730, he gave his salary throughout that period to various charities. Sloane was President of the Royal College of Physicians from 1719 to 1735, and was responsible for many improvements in the fourth London *Pharmacopoeia*, 1724. His interest in inoculation for smallpox greatly accelerated this important advance in preventive medicine. The *Philosophical Transactions*, 1716 contained an account of the practice sent by Dr Pylarini in reply to an inquiry made by Sloane through the British Consul at Smyrna. Sloane successfully inoculated members of the Royal Family.

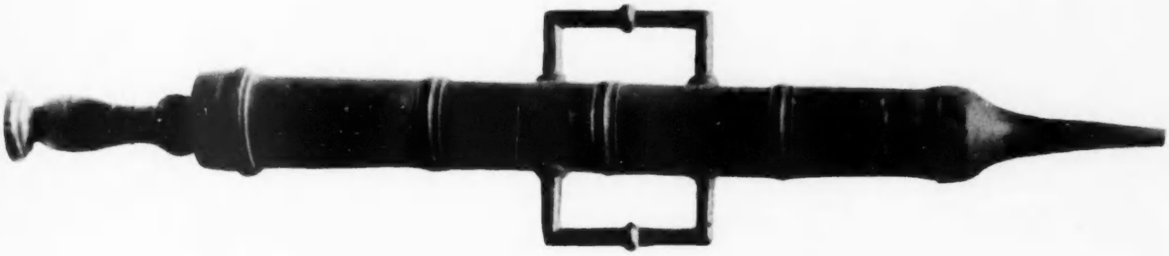
After he had purchased the Manor of Chelsea in 1712 Sloane presented the freehold of the Physic Garden to the Apothecaries' Society, who had leased it since 1673. He showed his wisdom by stipulating that the Apothecaries should supply the Royal Society with fifty new plant specimens annually, thus ensuring that the Gardens were well maintained and that the search for new specimens was not neglected. Sloane also initiated a scheme to transplant medicinal herbs from Spanish Central and South America to Georgia, but after the death of the botanist commissioned to collect specimens the project was abandoned.

Sloane, who died on January 11, 1753, bequeathed his unique collections to the public on condition that his family received £20,000. Their worth at that time was at least £50,000. The collection, which included over 4000 MSS and about 50,000 books, was opened to the public in 1759; Montague House having been purchased to house the material acquired from Sloane and from other sources. The British Museum might be regarded as Sloane's monument, but he would probably prefer to be remembered for his part in the development of botanical science.

FIRE-FIGHTING AND PREVENTION

E. A. HIBBITT

Senior Fire Prevention Officer, Manchester Fire Brigade



Apart from the development of new extinguishing agents for special risks, fire-fighting has changed little since the motor fire engine replaced the horse-drawn steamer. The most hopeful outlook is the prevention of large fires by automatic detection and attack at the source.

Scientific research to improve methods of fire-fighting and fire-prevention is of comparatively recent origin, but it is now being carried out by a large number of organisations throughout the world. Some of this work is sponsored by public bodies, but a good deal is being done privately by manufacturers of fire-fighting and fire-prevention equipment, and by fire insurance companies.

Water has always been the principal medium used for fighting fires, and it is unlikely that it will be superseded in the foreseeable future. Water is cheap, usually plentiful, and has the highest specific heat of any known substance, which gives it remarkable cooling properties. The difficulty has always been to find the best method of using it.

Theoretically, the ideal way to extinguish a fire with water is to use exactly the right quantity which, in vaporising, will absorb sufficient B.T.U. to cool the burning substance to below its ignition temperature. If this could be achieved the danger of damage by water to valuable commodities untouched by the fire would be eliminated. (It is not infrequent in fire-fighting for the water to cause more damage than the fire itself. This is one reason why the automatic sprinkler installation is not universally popular.)

EARLY EQUIPMENT

The syringe or squirt ("sipho", as the Romans called it), described in the writings of Hero of Alexandria, is attributed to the inventive genius of an Alexandrian engineer named Ctesibius. Apart from the simple bucket, it was the principal fire-fighting weapon, until the devastation of a number of towns by fire compelled the authorities to give some attention to improving their fire-fighting arrangements.

Many fire-engines were invented, but few had any practical value, until two brothers, Jan and Nicolaas van der Heijden, of Amsterdam, invented a manual pump, and for the first time used leather hose between pump and nozzle, thus enabling the fire-fighting jet to be taken close to, or even into, the burning building.

The Great Fire of London provided a stimulus to inventors in this country. It was immediately after the Great Fire that the first fire insurance offices were formed, and they soon sought to extend their custom by offering their clients the inducement of protection by the insurance office's own fire-brigade. The development by Newsham of an improved type of fire-engine enabled the newly formed brigades to be equipped with a pump which would give them a reasonable chance of extinguishing a fire if they could get to it in time.

Early fire-pumps were usually on sleds, and had to be loaded on to a cart to be taken to the fire. Later pumps were fitted with wheels and were manhandled to the fire. It was not until late in the 18th century that pumps were horse-drawn. By this time the pumps were so large as to require thirty men or more to work them. It was the custom to employ spectators for this work and to reward them for their exertions with a plentiful supply of beer.

The invention of the steam engine resulted in the gradual replacement of the manual engines by horse-drawn steamers, which were much more efficient, and enabled fire-brigades to dispense with the services of spectators whose motives in offering their assistance were often suspect. Many of these steam fire-pumps are still in existence, and their performance compares favourably with the best that the modern fire-engine can do.

The invention of the internal combustion engine caused a second revolution in fire-engine design, and the reciprocating pump was at last abandoned in favour of the centrifugal pump. The latter has, of course, the great advantage that the fire-fighting jets can be shut off without stopping the pump and without the danger of bursting hose.

The centrifugal pump, driven by a petrol or diesel engine,

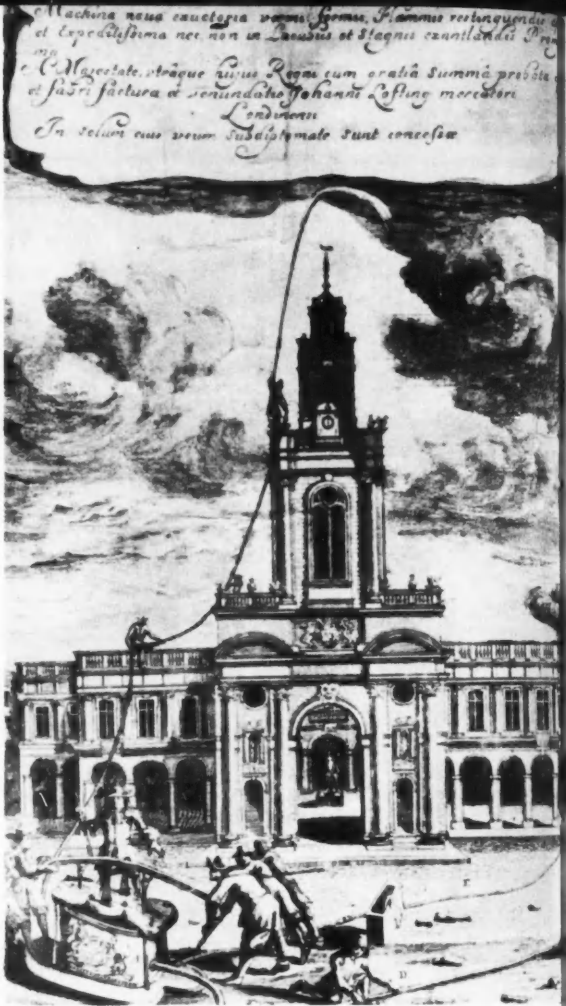


FIG. 2 (*above*). Use of Fire Hooks, 1612.

FIG. 3 (*right*). Lofting's Fire Engine, 1690.

FIG. 4 (*below*). Early German Engines in London, 1630.

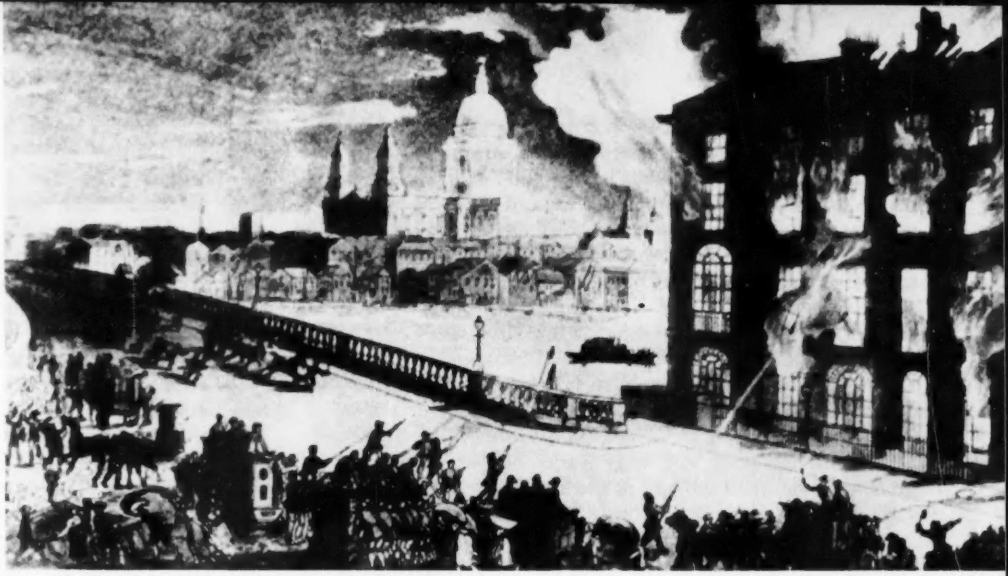


FIG. 5 (*above*). Albion Mill, 1791.

FIG. 6 (*left*). Old Manual Fire Appliance, 1710.

FIG. 7 (*below*). Sun Fire Engine proceeding to fire, 1820.

is today universally used for fire-fighting, and usually has an output of 500–900 galls./min. at a pressure of 100 lb./sq. in. Since the war there has been a good deal of research on the use of high-pressure pumps to produce a fire-fighting mist instead of the conventional solid stream. The advantages are obvious. The object of fire-fighting with water is to absorb the heat liberated by combustion by making it convert water into steam. This can be done much more efficiently by using the water in the form of a spray or mist, which gives it a greatly increased specific surface.

The principal disadvantage, so far as the fireman is concerned, is the obvious one that the more the water stream is broken up, the shorter is its effective throw. Fire-fighting is a warm business, and it is sometimes impossible for firemen to get close enough to the fire to use high-pressure spray successfully. Nevertheless, the enormous theoretical advantages to be gained from the use of this type of equipment, not only in increased efficiency in fire-fighting but also in the tremendous reduction in the quantities of water used, have influenced many brigades to equip themselves with this type of pump.

Recent research indicates, however, that there is little appreciable advantage in using very high pressures, and it would appear from experiments carried out that a pressure of about 100 lb./sq. in. is probably sufficient. The difficulty in using very high pressures is to find suitable flexible hose capable of withstanding it. Most fire-brigades' hose is either woven flax (called "canvas") or rubber-lined cotton or nylon, and is manufactured to withstand a working pressure of about 150 lb./sq. in. A hose which had to withstand a working pressure of 500 lb./sq. in. and at the same time retain the essential qualities of lightness and flexibility would have to be much stronger and would inevitably be much more expensive.

For comparatively small fires, which can be fought from close range, the water spray undoubtedly has a very real practical value, but it is quite unsuitable for fighting large fires with the equipment at present in use. Whether it will ever be possible to combine the advantages of water spray with equipment which will enable it to be used on large fires, without the fireman having to be roasted in the process, is extremely doubtful.

FLAMMABLE LIQUIDS

Fires involving flammable liquids are among the most difficult to fight. They occur frequently and may vary from a pan of fat to an oil storage-tank containing several thousands of gallons. They are usually extinguished by smothering in one way or another, although once again high-pressure water spray may be used to emulsify the surface and extinguish the fire by a combination of dilution and cooling. The simplest way to extinguish a fire involving a flammable liquid is to put a lid on it or throw some kind of blanket over it.

Where the fire is large, a smothering agent such as foam must be used. There is, in fact, a wide variety of smothering agents, but foam is the most commonly used and is used almost exclusively on the large fire. Experiments have been conducted for fighting fires involving crashed aircraft, in which up to 10,000 gallons of petrol or kerosene may be released into the fire by the impact. Carbon dioxide, if used in sufficient quantity (and one must think in terms of several tons of liquid CO_2), has some initial effect, but is too quickly dispersed, and even where extinction is achieved in the first attack, there is always a serious danger of a flashback as long as flammable vapours are present.

Bicarbonate of soda, to which free-flowing agents such as aluminium or zinc stearate have been added, has also been tried recently. This so-called "dry powder" is the latest development in extinguishing media, and the use of this powder in small hand-extinguishers is achieving spectacular results.

Its use in fighting large flammable-liquid fires, however, appears to be very limited, and it is unlikely that it will replace foam as the principal medium.

Foam is made by aerating a solution of a protein-base compound (largely derived from slaughterhouse waste) and water. The bubbles formed contain air, and are fairly stable, so that the foam will remain on the surface of the liquid, sometimes for several hours, before eventually breaking down. This is a useful quality in fighting fires involving a flammable liquid, because it enables the firemen to build up the foam blanket over the surface of the burning liquid until it is entirely covered. He can then allow it to cool without fear of a flashback occurring, as might be the case if an inert gas were used.

Research has shown that the fluidity of a foam is its most important property in controlling a fire, the greater the fluidity, the greater the effectiveness of the foam. At the same time, there is a critical rate of application which must be achieved if the fire is to be extinguished. Where this cannot be achieved because of a shortage of equipment or foam compound, very little will be accomplished by getting to work at all, and it would probably be better to allow the fire to burn until sufficient quantities of compound and the right equipment are available.

The technique in fighting crashed aircraft fires (provided they crash within striking distance of the airport's fire-tenders) is to smother the entire aircraft in foam within about three minutes, the whole output of specially designed foam-tenders being used for this purpose. Only in this way can they hope to extinguish the fire. To apply the foam at a lower rate would merely result in the foam's being broken down too rapidly for complete coverage to be achieved.

A technique has been adopted in the United States in recent years of "foaming" a runway whenever an aircraft is compelled to carry out a crash landing. The object is to damp out any friction sparks by carpeting the runway with foam to a depth of about four inches, thus reducing the danger of the ignition of spilled fuel from damaged tanks. No one has yet established that this is in fact what happens, and although there have been instances where the foaming of a runway has been successful, there have also been instances where it has not. The Ministry of Civil Aviation in this country remains unconvinced, and has instructed airport controls to inform any pilot requesting this facility that it cannot be done.

One factor in fire extinguishment which is still not properly understood is the inhibition of combustion by the vapours of certain liquids. The best known, although the

least efficient, is carbon tetrachloride, used in the familiar hand-pump carried on many motor-cars. The inhibitory effect of these compounds has been closely studied. Methyl bromide is another halogen compound commonly used, and has a much higher efficiency than carbon tetrachloride. Unfortunately, the vapours produced by the decomposition of these compounds when they are used on a fire are toxic and, in the case of methyl bromide, lethally so. They must, therefore, be limited in their use to places where the vapours are unlikely to be inhaled, and for this reason methyl bromide is principally used in fixed automatic installations such as are found in those parts of an aircraft inaccessible for fire-fighting when in flight; for example, the engine nacelles and fuel-tanks. For this purpose an extinguishing agent such as methyl bromide is particularly valuable because of the small quantities needed and the consequent saving in space and weight. Difluorochlorobromomethane is being used in some of the latest aircraft.

Chlorobromomethane, used in hand-extinguishers, has been commercialised with some success, and is to some extent replacing carbon tetrachloride. It is more efficient and less toxic, but more expensive. Experiments with other halogen compounds continue, but some of these are much too expensive to produce to be used extensively.

LARGE FIRES

The major problem in fire-fighting is still, however, the prevention of the large fire. It is significant that about three-quarters of the financial loss by fire in the United Kingdom is attributable to a comparatively small number of large fires. If some method could be found of preventing such fires from developing, the loss would be very considerably reduced.

So far, the methods of fighting such fires have been strictly traditional and largely abortive, the principal object being to prevent the fire from spreading to neighbouring buildings and to allow the affected building to burn itself out. This does not always happen, of course, and there have been many cases where a large fire has been controlled without the total loss of the building.

Nevertheless, the fire that caused the greatest single financial loss of all time, the destruction of the General Motors plant at Livonia in the United States, proved impossible for fire-brigades to control. The eventual bill of

FIG. 8 (*below*). A modern powder extinguisher.

FIG. 9 (*right*). The extinguisher in action against a petrol fire.

(*Figs. 8 and 9 by courtesy of Nu-Swift Ltd*).

$53 million was met in large measure by British insurance companies.

In 1957 the Fire Research Station at Boreham Wood, Herts., began to consider the possibility of using the humidified exhaust gases from a jet engine to control a large fire at least long enough for firemen to get to the seat of the fire with their jets. The greatest difficulty in fighting large fires, particularly in basements, is that the accumulations of smoke and heat prevent the firemen from fighting the fire at close quarters.

Arrangements have now been made to carry out practical tests with a jet engine loaned to the Research Station for this purpose. The problem now arises of carrying out experiments on a scale large enough to reproduce as nearly as possible the conditions likely to be met in practice. Work is at present being done on a model to produce a scale equation which could be used to relate the results to a fire in a large building. The results of these experiments are awaited with interest.

THE ARITHMETIC OF FIRE-FIGHTING

The most profitable field of research must, of course, be in prevention, but it must be realised that the elimination of all possibility of fires starting is impossible as long as combustible materials of any kind are used in buildings.

Despite the developments that might take place in fire-fighting technique, it is unlikely that any serious reduction in fire loss will be achieved without a much wider use of automatic fire-protection equipment. The link between the fire and the fire-brigade is too dependent on chance, and in many cases the size of the fire on the arrival of the brigade has precluded any possibility of saving the building or its contents.

In this respect the present investigation being carried out at the Fire Research Station into the growth and spread of fire may prove of the greatest importance. There is a stage in the development of a fire when the heat output from the burning materials is such that the best efforts of the fire-brigade in pouring water on to the blaze are quite useless except in checking the spread of the fire to neighbouring buildings.

An attempt has been made to evaluate the combustibility of a building and its contents by assessing these in terms of B.T.U. per square foot of floor area. This is referred to as the "fire load". For example, if a single floor of a warehouse building contains 100,000 lb. of combustible material of an average calorific value of 8000 B.T.U./lb. distributed over a floor area of 4000 sq. ft., the fire load can be calculated as follows:

$$\frac{100{,}000 \times 8000}{4000} = 200{,}000 \text{ B.T.U./sq. ft.}$$

The total potential heat output of this floor, however, would be 800,000,000 B.T.U., and the whole of this would be released very rapidly once the contents of the floor had been heated to their ignition temperature. This might occur within some twenty minutes of the fire starting, depending on a number of factors including the presence of an adequate supply of oxygen. Where, because of closed doors and windows, sufficient oxygen is not present to allow complete combustion to take place, the gradual build-up of heat from a slow smouldering fire will increase the air temperature in the room, thus increasing pressure until a stage is reached when one or more windows will be pushed out, allowing a fresh supply of air to reach the fire. This usually results in a sudden flash-over when the entire combustible contents of the room, already at their ignition temperature but which have failed to burn because of oxygen starvation, will burst into flame. If this is the sort of situation which meets the fire-brigade on arrival, they are faced with an almost impossible task in controlling the fire.

Every fire-brigade, despite the highest standards of training and efficiency, and with the best equipment in the world, must take some minutes to build up its attack on the fire. A start is made with one fire-fighting jet, then two, three, and so on, until perhaps twenty or thirty jets are at work. Each jet will be pouring water into the building at the rate of about 100 galls./min., and every pound of water is capable of absorbing 1000 B.T.U. in being converted to steam. With ten jets working, a total of 1000 galls./min. will be pouring into the building. Much of this will, unfortunately, run to waste, but assuming that the whole of it is converted to steam, the maximum absorption of B.T.U. cannot possibly exceed 10,000,000 B.T.U./min. On the other hand, the release of energy by the burning of combustibles is going on at the rate of some 40,000,000 B.T.U./min.

In practice, the fire-brigade is much worse off in its efforts to fight the fire than these simple calculations show, largely because of the inefficiency of its equipment, which concentrates the attack in a number of isolated places instead of uniformly over the whole floor area, and because of the comparatively large quantity of water that never reaches the fire, failing to enter windows, for example, and running to waste down the outside of the building.

This is why so many fires in large buildings result in the total loss of the building and its contents. The heat output of the burning materials far exceeds the potential heat absorption of the total quantity of water that the fire-brigade can possibly pour into the building. The experienced fire officer knows this and prefers to use his resources to prevent the fire from spreading, allowing the main fire to burn itself out.

The present building by-laws have gone some way towards limiting the possible spread of fire by requiring that the elements of a structure shall possess a certain degree of fire resistance. The building by-laws do not, however, limit the size of the building, nor do they impose any limitation on the cubic capacity of any single compartment.

The construction of buildings used for trade or manufacture of several million cubic feet without any internal fire partitions is not uncommon. As a consequence, several local authorities are incorporating in private Acts similar powers to those contained in the London Building Acts whereby special fire precautions may be required in buildings above a capacity of 250,000 cu. ft. This figure has been

FIG. 10 (*right*). A big blaze in a furniture store at Ilford.

FIG. 11. A Modern fire engine. *(By courtesy of Dennis Brothers Ltd)*

chosen as representing the largest size of compartment in which it would be possible for the fire-brigade to fight a fire with any real hope of success. Above this size it is usual to require that an automatic sprinkler installation should be provided.

AUTOMATIC EQUIPMENT

Automatic fire-protection equipment is designed either to detect the fire and call the fire-brigade, or to detect and attack the fire simultaneously, as in the case of the automatic sprinkler. There is little purpose in installing equipment which will merely detect a fire without calling the fire-brigade.

Automatic detectors may be of several types, heat-sensitive or light-sensitive, the commonest depending for its operation on the thermal expansion of metal. The sensitivity of all these detectors is capable of adjustment, but the degree of sensitivity must not be such that false alarms will be caused.

One type of detector employs a small radioactive source which renders the air in an open chamber in the detector electrically conductive by the emission of alpha particles. Combustion products from a fire enter the chamber and radically change its electrical characteristics. This change triggers a cold cathode electrometer tube which then passes current to operate a relay.

Experiments have been conducted with infra-red detectors, but these have been limited to explosion suppression and to the location of the seat of a fire through smoke. The difficulties in the way of a wider use of this type of detector lie in the fact that infra-red rays travel in straight lines and can be interrupted. This obviates their use in premises where fires might start in places which would be shielded from the detector.

CONCLUSION

Fundamentally, fire-fighting has changed little despite improvements in pumps and hoses, and the success of the fire-fighters is directly related to their experience and courage rather than to the technical efficiency of their equipment. There is little hope that matters will improve to an extent that will make any material difference to the speed and efficiency with which fires can be fought. The use of the humidified gases from a jet engine may prove successful in controlling the large basement fire, but the prospect of achieving useful results in large buildings which are well alight on the arrival of the brigade is extremely remote.

There are two ways to prevent the large fire. Either it must be detected and attacked at its source before it can grow and spread, or the size of any single compartment must be limited by law. The second is a negative approach, and in modern industrial continuous-process plants is quite impracticable. There is no reason, however, why the law should not permit these large uncompartmented buildings provided that automatic fire-protection equipment is installed. If this were done the number of large, expensive fires would certainly be gradually reduced.

NEW SCIENTIFIC INSTRUMENTS

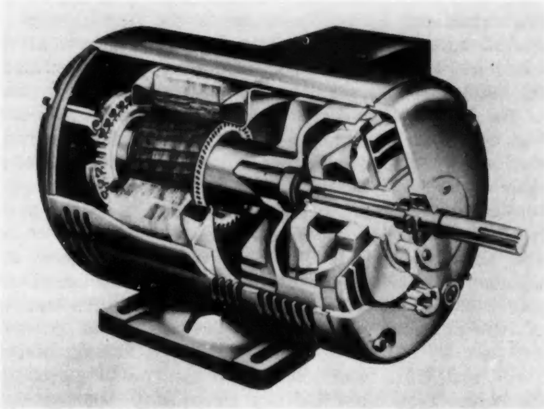
ARTHUR GARRATT

Manufacturers in this country and abroad are invited to send information about New Scientific Instruments as early as possible to the Editor for review.

Space exploration is acting as a spur to instrument development and it has been announced in the U.S.A. that a new 50-lb. gyroscopic **Far Infra-red Scanner** has been built. Using a 12-in. aperture and a super-cooled detector consisting of a single crystal of germanium combined with relatively volatile elements, it will detect objects having relatively low surface temperatures, such as the outer skin of a satellite. All the components can be rotated as an integral unit so that the instrument remains stable during spins or turns of a rocket carrier. It can be used for the detection of missiles or to detect heat from stars, planets or satellites and so operate as a space navigator.

Gyroscopes with very low drift rates are of immense value for navigational purposes. The **Gyrosyn Compass** Series 11 reduces frictional effects to a minimum by employing contra-rotating bearings. Gyro wander is reduced to less than 1°/hr., ten times less than ordinary service compasses, so permitting latitude compensation in the slaved or free gyro operation in either hemisphere.

Miniature temperature recording instruments are of great use to industry to record temperatures in confined spaces. The **Minican Temperature Recorder** is small enough to place in a can or bottle subjected to industrial processes, for example, passing through a conveyor oven. The recordings are on a 40 mm. chart from a stylus moved by an expansion system. It will operate for 2, 12, or 24 hours and is accurate to 0·5 mm. of the chart width. Its range is −30°C to 160°C with a minimum span of 50°C. It is liquid- and gas-proof and will withstand a pressure of 30 lb./in.^{2}



Combined motor/coupling unit giving infinitely variable speed over a wide range.

Two new **Moisture Gauges** are now available. One, the Ekco, is a transistorised instrument primarily designed for determining the moisture content of paper. It is a capacity device and it is claimed that measurements in the range 2% to 15% moisture content are obtainable with a repeatibility of $\pm\frac{1}{4}\%$. It can be coupled to a beta gauge to correct the latter for moisture and ensure an accurate "dry weight" reading. The other moisture meter is made by Shaw, who claim a sensitivity 100 times greater than any other type together with a range of 10 million to one. The element, details of which are not released, is said to be stable and to have a life of several years. It is a transistorised remote-recording unit with a response time of one second.

A combined **Motor/Coupling Unit** is announced. This is capable of giving infinitely variable speeds over a wide range and it is suitable for duties up to 2 h.p. A small built-in tachometer provides a speed-sensing signal for feed-back speed control. The unit is an integral combination of a quill-mounted, squirrel cage motor and an air-cooled eddy-current coupling system mounted in a common housing (see photograph).

The Distillers Co. has developed a **Continuous Oxygen Analyser** which exploits the paramagnetism of oxygen to produce a force on a test body suspended in a non-uniform magnetic field. The force is balanced by electro-magnetic feedback. It is stable and gives a rapid response making it suitable for automatic control loops. Six switched ranges cover 0 to 1% up to 0 to 100%. It is specifically designed for the continuous recording of the oxygen content in chemical plant gases.

Another gas analyser of quite a different type designed for a very different purpose comes from the U.S. It uses gas chromatography to measure the oxygen, nitrogen, and carbon dioxide in two drops of blood in about two minutes. **The Toxic Gas Analyser** can be used to detect prolonged exposure of a patient to small concentrations of gas which do not produce readily recognisable symptoms and it also has applications in anaesthesia.

A **Blood Pressure Recording Instrument** for use with Statham blood pressure transducers provides a system of high stability and accuracy with freedom from drift. A transistorised pre-amplifier incorporates electrical damping control so that optimum damping conditions can be pre-arranged for any combination of head with catheter or needle used for cardiac catheterisation or surgical procedures.

An **Echo-Encephalography Apparatus** shows great promise for rapid diagnosis of brain displacement in patients who have suffered head injury in accidents. The apparatus is a modified Kelvin & Hughes Flaw Detector Mk V using barium-titanate crystal probes placed on each temple with a water-base jelly to exclude air. A high-speed changeover switch enables traces from each side of the skull to be displayed apparently simultaneously on a cathode-ray tube. One trace is in positive sense, the other negative on the Y plates, with a triggered time-base applied to the X plates. A strong echo is received from the structure in the middle of the brain although the precise source of the echo is not yet fully established. Any displacement of the brain laterally is immediately apparent by asymmetry in the pattern—a

1 mm. displacement is readily detectable. Experiments are in progress with animals to test that the very small energies used do no damage to the brain: present evidence suggests that the risk of using this technique is negligible.

There is news of two new computers. One, the **Simlac Minor** is a small-capacity general-purpose analogue computer. It has 32 amplifiers and 100 passive elements. Although oven-stabilisation is not used, in order to keep the dimensions of the instruments as small as possible, the overall accuracy of the computing elements is 0·1%. The other new computer, the **IBM 7080**, is a transistorised version of the IBM 705. It can process work at high speed, for example, in one second it can make 303,000 logical decisions or read or write 312,000 characters of information on magnetic tape. There are two units of magnetic core storage, each with an access time of 2·18 μsec. which together hold 160,000 characters of information. There is an auxiliary storage of 1024 positions with an access time of 1·09 μsec.

ICI and ETL have jointly developed the **Nobel Type Load Cell** for electrical weighing systems. The cells have extremely high stability and less than 0·2% zero shift can be expected after sustained loading over periods of a year. An accuracy of $\pm 0{\cdot}25\%$ is possible in weighing installations using these cells. They are unaffected by corrosive atmospheres and they will tolerate a 50% overload without permanent ill effects. Six standard types covering weights up to 100,000 lb. are available and special cells can be made to order.

An **Air Gauge**, developed jointly by Sperry and Mercer, can be used during grinding operations to give a visual representation of the amount of metal to be removed at any instant. A shoe contacts the work on two shoulders which are not ground in the particular application. Jets of air then sense the work surface and the efflux is translated into meter readings calibrated in ten-thousandths of an inch.

Another production tool, this time for cutting semi-conductor crystals and glass tubes for glass-to-copper seals, is announced. It will cut at infinitely variable feed rates from 10 in. to 1000 in. per hour with a repetitive accuracy of indexing of about ± 1 thou. This **Hydro-Pneumatic Cutting Machine** is already in operation slicing germanium transistor elements.

MANUFACTURERS

Far Infra-red Scanner. Martin, Baltimore 3. Maryland, U.S.A.

Gyrosyn Compass. Sperry Gyroscope Co. Ltd, Great West Road, Brentford.

Minican Temperature Recorder. Cambridge Instrument Co. Ltd, 13 Grosvenor Place, S.W.1.

Moisture Gauges. Ekco Electronics Ltd, Southend-on-Sea, and Shaw, Rawson Road, Westgate, Bradford.

Motor/Coupling Unit. Heenan & Froude Ltd, 30 St James Square, S.W.1.

Continuous Oxygen Analyser. Servomex Controls Ltd, Crowborough, Sussex.

Toxic Gas Analyser. Fisher Scientific Co., Pittsburgh, Pa., U.S.A.

Blood Pressure Recording Instrument. AEI Ltd, 155 Charing Cross Road, W.C.2.

Echo-Encephalography Apparatus. West End Hospital for Neurology and Neurosurgery, W.1.

Simlac Minor Computer. Short Bros. & Harland Ltd, Seaplane Works, Queens Island, Belfast.

IBM 7080 Computer. IBM United Kingdom Ltd, 101 Wigmore Street, W.1.

Nobel Type Load Cells. Ericsson Telephones Ltd, Beeston, Nottingham.

Air Gauge. Sperry Gyroscope Co. Ltd, Great West Road, Brentford.

Hydro-Pneumatic Cutting Machine. GEC Ltd, Magnet House, W.C.2.

LETTERS TO THE EDITOR

Science on American Television

Sir,

I have read with considerable interest Mr Garratt's brief, but thorough, review of "Science on American Television". His review should lead those of us who are professionally concerned with science education to ask again the basic question, "What is the unique role of television in science education?"

Certainly, through television Mr Everyman should have a chance to become better informed about those areas of science, ranging from the exploration of space to demography, in which he has a vital stake. In no nation have the potentialities of television for mass science education been sufficiently explored. Television's major educational contribution may be in this direction.

Through television, scientists, technicians and science teachers can keep informed of recent developments in their fields. In the same issue of DISCOVERY, D. Michie, with part of his tongue in cheek, suggests that scientific material should be presented in such a way that the consumer can enjoy it. Perhaps this is a good advice for those who plan and produce science programmes on television. "Sunrise Semester" has been enjoyed by thousands of science teachers even though unfortunate scheduling forced them to swallow it along with an early breakfast.

But, what is the role of television in the science classroom? Having seen attempts at using television for direct teaching, it is difficult for me to believe that the phosphorescent screen will ever replace the flesh-and-blood teacher. The British approach of providing programmes that the skilled teacher can use to enrich the science programme of his students appears to be a much more fruitful approach. However, much more research is needed to find the most effective ways of using this important new medium in the classroom. WILLARD J. JACOBSON

Teachers College, Columbia University, New York 27, N.Y.

Antarctic Treaty

Sir:

In your issue of last December (1959, Vol. 20, p. 508), you discussed the Antarctic Treaty which was signed at Washington on December 1, 1959. The welcome you gave to the treaty will be endorsed by all scientists interested in that region. But on one point of fact you were misinformed. Your statement "The role previously played by naval vessels and other military forces must cease" does not accord with Article 1, paragraph 2 of the Treaty, which reads "The present Treaty shall not prevent the use of military personnel or equipment for scientific research or for any other peaceful purpose". Thus, while warlike operations are properly banned, the continued use of certain facilities hitherto provided by service departments in some countries is expressly permitted. T. E. ARMSTRONG

Scott Polar Research Institute, Cambridge.

Addendum

In our description of the solar furnace at Bouzaréah, "Progress of Science in the Sahara", March 1960, we forgot to mention that the solar furnace is part of the Institute of Solar Energy of the University of Algiers and that its Director is Prof. Marcel Perrot. It should also be borne in mind that the photograph on page 103 is of the reaction vessel at the focus of a smaller parabolic mirror and not of the main instrument shown on the cover.

GEOPHYSICS AND SPACE RESEARCH

By ANGELA CROOME

Venus Unobserved

What promises to be the most interesting space probe so far launched was successfully fired under NASA auspices from Cape Canaveral on March 11. It is the first space-vehicle to be launched inward towards the Sun, and the third vehicle to go into a solar orbit (the others being *Lunik I* and *Pioneer IV*). This was the shot originally scheduled for firing last June when it had a chance of making a near-miss of Venus at the planet's close approach to the Earth in September. It was to be the climax of a series of four launchings, one of which, last August's "paddlewheel" satellite *Explorer VI*, overwhelmingly proved the method of launching and has been of the greatest scientific value. Another U.S. probe will be launched to reach the vicinity of Venus during next January when the planet will again be at the closest point in its orbit to the Earth.

Pioneer V, as the new artificial planetoid is called, reached to within 150 m.p.h. of its intended maximum speed at launch. The three-stage *Thor-Able* rocket that carried it into orbit achieved a top speed of 24,869 m.p.h. The last stage was fired by radio command from Jodrell Bank. The effect of the slight error in the launching speed means, that instead of intersecting the orbit of Venus as was intended, the satellite's entire orbit will lie outside the planet's orbit though at its closest it will approach to within 7 million miles of Venus's path. *Pioneer V*'s orbital period is expected to be 311 days (a 295-day period was planned) in comparison with the 225-day period of Venus and the 365-day period of the Earth. At apogee it will lie 186 million miles from the Earth. It will then be 74,700,000 miles from the Sun. The mean distance of Venus's orbit from the Sun is 67 million miles and that of the Earth 93 million miles.

The instrumentation of this satellite is likewise an expansion and development of the experiments carried in the "paddlewheel". They are principally concerned with radiation and the effect on this of magnetic fields in space.

The value of the satellite stands or falls on the effectiveness of its radio transmission over vast distances. To achieve this two transmitters are carried—a 5-watt equipment to operate over the first few million miles of the flight and a 150-watt transmitter to handle the data from this point out to 50 million miles. The second transmitter is some twenty times more powerful than any instrument previously carried by an American space-vehicle. Solar cells arranged in the familiar "paddlewheel" configuration to make use of the maximum amount of solar energy maintain the power of the satellite's batteries. Further, to conserve power, the transmitters will only be switched on for brief periods each day. This is done on radio command from Jodrell Bank. Without the giant telescope the project would hardly have been feasible at all at this time. The gathering power of the big dish is such that it is hoped to receive signals from the satellite out to 50 million miles, rather over a quarter of the distance to apogee. This point will be reached some time in July. Thereafter the satellite will travel switched silent. Not until a date in 1963 will the relative distance of the Earth and *Pioneer V* again approach to within 50 million miles of each other. It will be a triumph indeed if at that distant date the transmitter can again be switched on and it is found that the instruments are still in operation.

The amount of data that may be collected between now and July is nevertheless formidable, and likely to pose a tough problem in data analysis and evaluation for the Americans.

The Significance of *Pioneer V*

It is perhaps worth while to dwell a little longer on the scientific potentialities of *Pioneer V*, since if all goes well these are likely to be of much grander sweep than any space experiments that have preceded it, including even the photography of the back of the Moon by the Russian *Lunik III*. *Pioneer V* has the possibility of unravelling many of the best-kept secrets of the solar system itself.

1. The probe may be able to tell us about the shape and intensity of the interplanetary magnetic field, for instance, which is much in dispute. The models proposed for this field at present vary from—at one extreme, a field that is quite smooth and dipolar extending round the Sun to a model that shows a highly irregular field with patches where the lines of force are all twisted up.

Pioneer V's magnetometer can only show the strength and direction of the field along the path of the probe, but the combination of these readings with the cosmic ray intensity counts should give information on the properties of the field over large regions of space.

2. It will be interesting to see whether there are "bumps" in the cosmic ray intensity within the Sun's magnetic field. If so, it would suggest that solar flares produce a solar equivalent of the *Argus* radiation shells that were artificially injected into the Earth's field by high-altitude atom bombs in the autumn of 1958 and remained in place about the globe for many weeks (see DISCOVERY, 1959, vol. 20, Nos. 5 and 7). Solar flare particles in the Sun's field would be likely to produce radiation shells of considerably greater intensity than those spread round the Earth by the *Argus* atom bombs.

3. Another possibility is that there are "clouds" of hot plasma containing solar particles in the vast stretches of interplanetary space. It may even be that the long-sought reason for the high temperature (1,000,000°) of the corona will be revealed by the *Pioneer*'s instruments.

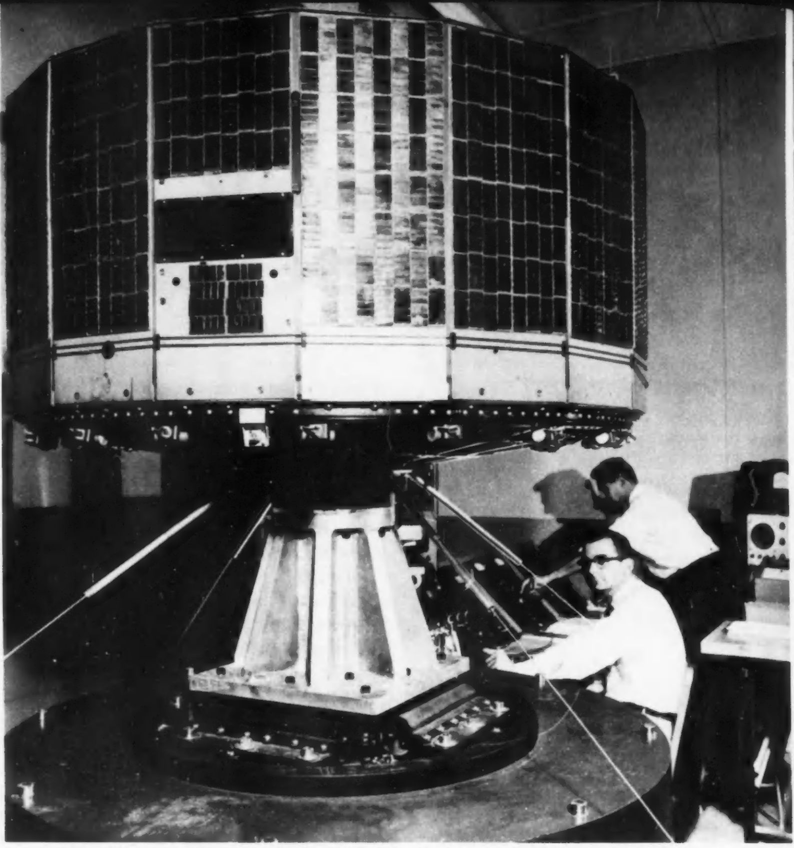
4. With regard to the Van Allen belts, geophysicists are at present divided into those who consider that the particles forming the shells of radiation round the Earth derive from the Sun, and those who think they originate through the incoming cosmic rays. If the former view is correct the probe should encounter some of these particles during their journey from the Sun and be able to identify them. The occurrence of *aurorae* and magnetic storms are closely related with the behaviour of outflung solar particles so that *Pioneer V* may be able to illuminate all these questions.

5. Another controversy centres on the cause of the so-called zodiacal light, the cone-shaped luminosity in the sky pointing away from the Sun in the plane of the ecliptic that can only be seen under very

good conditions. How much of this light is due to the scattering of sunlight by dust particles in interplanetary space? How much dust is there in these regions? As yet no one can be sure. *Pioneer V* carries an interplanetary dust or "micrometeorite" detector and so perhaps will tell us.

A Russian Bathyscaphe planned

Soviet engineers are at work on the designs for a bathyscaphe of comparable performance to that of the U.S. Navy's *Trieste* designed by the Swiss pioneer Prof. August Piccard. The Russian bathyscaphe will consist of a light float body with the crew nacelle suspended beneath it. It is intended that it should be able to reach to a depth of about seven miles, 36,000 ft. Besides being equipped with special fish snares and harpoon guns it will carry apparatus able to transform ultrasonic frequencies into audible sound frequencies for recording on tape. This will enable fish noises to be studied. It is not known when the bathyscaphe is due for completion.



The *Tiros* satellite, launched on April 1, is given a vibration test at the Astro-Electronic Products Division of RCA, Princeton, New Jersey. Containing two television cameras, *Tiros* is designed to take still pictures of the Earth's cloud cover and transmit them to ground stations. The project is sponsored by NASA. The satellite was designed and constructed by RCA under the technical supervision of the U.S. Army Signal Research and Development Laboratory, Fort Monmouth, New Jersey.

Micrometeorites as Rainmakers

What causes rain? After ten million years' experience of it, we still do not really know. The incompetence of man's efforts to produce it when there is a drought or stop it when inundation threatens, underlines this.

Some years ago Dr E. G. Bowen, the distinguished physicist who is head of the Radio Physics Division of Australia's CSIRO, astonished the meteorological profession by the proposal that there was an intimate connexion between periods of heavy rainfall and meteor showers. This was an intriguing hypothesis and extremely hard either to prove or disprove. It was a temptation to wish it true since it would greatly simplify artificial rainmaking operations if successful "seeding" could be accomplished with metallic or glassy granules in lieu of the expensive chemicals that have so far proved the most promising.

One way to substantiate or repudiate the theory was to confirm that there are regularly occurring peaks of rainfall all over the world and have been as long as records have been kept and that these correlate with the incidence of meteor showers. In the light of this hypothesis statistical analysis of the records of long-established weather stations was needed. This has taken time to carry out but the gaps are beginning to fill up. The upshot is that confirmation on both points is appearing; that is, that there are dates on which rainfall peaks occur regularly over the years and that there is a correlation between these and meteor showers falling about a month earlier. Both American and Russian meteorologists have reported in this sense on the first point. The Russians go further and find a positive correlation between peaks of increased raininess on definite calendar dates and the occurrence of meteor showers thirty-one days before.

In contrast, the investigation of the problem by cloud physicists has increased the original doubts on its soundness. There are two main difficulties. Why should the meteoritic particles take thirty days to fall from about 100 km. up, to the troposphere, where they may nucleate clouds and so actually bring about rain? Secondly, will ice crystals form on meteoric material to produce the droplets that we know as rain?

The slow sinking-time required by Bowen's hypothesis presupposes that the upper atmosphere is still. This model is no longer tenable. It is now known that the region above the troposphere is often extremely turbulent.

Very recent work by the Japanese and at Imperial College by B. J. Mason on the ice nuclei of rain clouds indicates that meteoritic material is almost useless as an agent of crystallisation. The Japanese have been studying the composition of actual ice nuclei collected from rain clouds. They have found that 90% are soil particles, 75% being from the kaolin group which occurs plentifully in dust sucked up from the Earth's surface and in the material ejected into the atmosphere by volcanoes. B. J. Mason has been trying to grow ice crystals on crushed and vaporised meteoritic material of both the metallic and glassy varieties under conditions simulating those in the atmosphere. Both types of crystal are highly reluctant to grow, the metallic meteorite dust being, if anything, worse than the silicate. Kaolinite soil particles, on the other hand, have proved the most active nuclei of crystallisation so far investigated.

Perhaps we are not so far from learning the origin of rain, and are thus a step nearer controlling rainfall. Of course, when this occurs it will require an international law of the clouds to adjudicate between rival claims.

SPACE CALENDAR

MARCH

4 Bell Aircraft Co. awarded $1½ million contract for cooling system for re-entry vehicles. The principle involves double walls with a cooling liquid circulating within.

7 V. Davidov of the Sternberg Institute suggests that the "canals" of Mars may be ice fissures due to the escape of subterranean heat and outlined by vegetation which flourishes in these relatively mild conditions.

10 Count-down for *Pioneer V* space probe reached −70, when it was called off because of a fuel-feed fault.

11 *Pioneer V* successfully launched at 1 p.m. GMT; picked up by Jodrell Bank, 1.12 p.m.; third stage separated by radio command from Jodrell Bank, 1.25 p.m.

12 *Pioneer V* radio-commanded at 375,000 miles, thereby breaking the long-range radio-command record set in October 1959 for *Lunik III*.

14 Signals received from a transmitter more than 406,000 miles away for the first time when *Pioneer V* was picked up by Jodrell Bank at a distance of 430,000 miles.

16 The Army Ballistic Missile Division, Huntsville, Alabama, was renamed the George C. Marshall Space Flight Centre. It was recently put under full NASA auspices.

17 Second anniversary of the launching of *Vanguard I*. It was announced that the orbit is being deflected by photons from the Sun at the rate of 1 mile a year.

18 *Pioneer V* reached 1 million miles and Dr K. Glennan, head of NASA, switched over to second data transmitter, by the press of a button, to mark the occasion.

19 Release of the names approved by the U.S.S.R. Academy of Sciences for identifiable features on the back of the Moon. Among the scientists commemorated are the Russians Kurchatov, Lobachevsky, Mendeleyev, and Popov. Among other scientists so honoured are Clerk, Maxwell, Jules Verne, Edison, Hertz, Pasteur, Giordano Bruno, and both the Curies.

21 Draft statutes for outer space discussed in Paris by an *ad hoc* working group of international lawyers set up by the IAF and chaired by Christopher Shawcross, Q.C.

APRIL

1 American cloud-cover satellite *Tiros* (Television and Infra-red Observation Satellite) successfully placed in orbit 400 miles high. It was equipped with two sun-powered television cameras and with infrared sensors. Lifetime: about three months.

Keeping track of *Scout*

However ingeniously a space-vehicle may be instrumented, it is of little use unless a high proportion of the data it collects is recovered. To ensure this a miniaturised tape recorder will be incorporated in the *Scout I* instrument package. This will store data during the sections of each orbit when the satellite is out of radio range of telemetry tracking stations.

The tape recorder will be a considerably more sophisticated affair than the pioneer apparatus of this kind, which was contained in *Explorer III* to record data for the State University of Iowa cosmic ray experiment, and in fact confirmed the presence of the previously unknown belt of radiation surrounding the Earth, the Van Allen belt. (See DISCOVERY, 1959, vol. 20, No. 5, p. 220.) The *Scout I* tape recorder, which is being designed by NASA for this vehicle, will register data from all the experiments carried and will therefore have a comparatively wide wave-band. It will be operated in conjunction with solar cells. These should greatly lengthen the satellite's operational lifetime, just as the tape recorder should much increase the effective usefulness of the apparatus carried. Taken together, they ensure that the optimum value is gained from the vehicle. The total weight of *Scout*'s radio equipment, power sources, data storage facilties and associated circuitry is approximately 100 lb. —in contrast to the 25 lb. available for instrumentation. A switch that will automatically switch off the satellite's radio at the end of a year in orbit is expected to be incorporated in the package also.

The network of primary tracking stations is to be increased in time for the *Scout* programme. The principal addition will be equipment operated by Radio Research Station, Slough (World Data Centre C for satellites and rockets) at a nearby site in Windsor Forest. This is to consist of a full-scale Minitrack installation provided by the Americans which will not only be able to track and receive telemetry from *Scout* at 136 Mc/s, the new prime frequency for space-vehicles adopted by COSPAR at the January meeting, but can also operate over the 108 Mc/s range used in the *Vanguard* and *Explorer* programme. In addition, Slough is to have an 80-ft. radar dish for radio acquisition of distant probes and high-precision "fixes" by radar. This will ease the pressure on Jodrell Bank's big telescope which was never intended for these jobs, although it proved to be the only instrument in the world capable of performing them during these first years of the Space Age.

The Slough station will hold a key position in the *Scout* tracking network. This is because its latitude lies towards the "turn" in the orbit at 55° where the satellite ceases its northward travel and begins a southward pass. A tracking station near this latitude is thus in radio contact for twice as long as one on the Equator for instance. Another Minitrack station is being considered and may be set up under British auspices at a comparable southern latitude. The Falkland Islands is a likely situation, being at a suitable southern latitude, and because the Radio Research Station already operates a sub-station there.

Mullard Radio Astronomy Observatory

In our list of the world's large radio telescopes on page 126 of the March issue, the world's largest radio telescope at Cambridge University was not mentioned. Of the two instruments working there, the larger, 1 km. in length, has a collecting area of three acres, operates at a frequency of 38 Mc/s, and is designed to study the structure of the galaxy. It uses the principle of aperture synthesis to obtain a beamwidth to half power of $50' \times 50'$ arc.

The second is the radio star aerial operating on a frequency of 178 Mc/s. This consists of a cylindrical paraboloid 65 ft. in width and 1450 ft. in length, together with a smaller movable aerial (190 ft. long) mounted on railway lines 1000 ft. in length. By the method of aperture synthesis, a beam of $25' \times 35'$ arc can be obtained and a large part of the sky has been surveyed by this method since the aerial came into operation in August 1958. This resolution is the same as that of two paraboloids 700 ft. in diameter. The fixed aerial alone has an area of two acres and a beamwidth to half power of $15' \times 4°.5$ which compares favourably with any of the instruments mentioned in our table.

The complete instrument is the most powerful at present in existence for the detection of radio stars. It was described and illustrated, shortly after its opening, in DISCOVERY, 1957, vol. 18, No. 9, p. 372.

THE BOOKSHELF

Science (Chemistry, Physics, Astronomy)

By an Editorial Board and Thirteen Contributors. Illustrated and designed by Hans Erni (*Macdonald Illustrated Library, London, 1960, 367 pp., 45s.*)

In the beginning was the word, then, perhaps, followed the picture. So it was with the book. It started with the printed text, to which illustrations were added, and according to the available techniques, they improved from wood cuts and steel engravings, through monochrome to colour photography. To transmit information by a complete integration of word and picture is still a very recent innovation, and in the field of science has its origin in *Life's* memorable series "The World We Live In" (1952). Rathbone Books took up this technique, and perhaps one of their best works was L. Hogben's "Man Must Measure" (1955). However, in both these works, and in other similarly richly illustrated books, the art work was always that of an illustrator, never that of the real artist.

In "Science" we have for the first time the authentic scientific text—richly supported by line drawings, photographs, and diagrams—integrated with the paintings of the Swiss artist Hans Erni. To many English readers his work will be new, although his continental and American reputation as an outstanding modern painter is richly deserved and dates from his first murals in Switzerland in 1935. If the test of a really great artist is the timelessness of his work, then the reader should look at Erni's "Spirit of Chemistry" (pp. 82–3) executed in 1944 for CIBA Basle; sixteen years later, it is still completely modern and scientifically up to date. Few of the other contributors to this book can hope to pass the same test.

In its introduction, the editorial board—composed of two biologists, one scientific philosopher and a journalist (Sir Julian Huxley, James Fisher, J. Bronowski, and Sir Gerald Berry)—set down the aim of this "first volume in a library of knowledge". It is "to make books with which boys and girls can grow up . . . above all within which they can make their own discoveries". Their aim is completely fulfilled through the clear and sensible text, through the many splendid illustrations, and above all, through the design and the paintings by Hans Erni. The texts range widely, and for example the chapter on Chemistry of Living Things, deals with chemical research equipment, photosynthesis, and respiration, the synthesis of cellulose in plants and of rayon viscose in the laboratory, petroleum chemistry, the destructive distillation of coal, the process of polymerization, the function of enzymes and catalysts, protein molecules, and the future of chemistry; each of these aspects is communicated on two full pages with about three or four illustrations per page. This, like all the other chapters in the book, contains two beautiful paintings by Hans Erni, and concludes with two pages of relevant numerical data.

The book concludes with a thirty-three-page dictionary giving definitions of 1000 useful science words and an excellent nine-page cross-referenced index. The biggest fault of this work is the absence of any information where further knowledge can be found, once the reader had his appetite whetted; a brief bibliography or even a short list for further reading might have been easily included, and this should certainly not be forgotten in subsequent volumes. Also the title "Science" is far too broad. After all the whole of the biological, social, and engineering sciences remain to be covered. Apart from these minor points, the team concerned with designing, writing, editing, illustrating, and producing of this magnificent work must be sincerely congratulated. A. R. MICHAELIS

The Buzzard

By Frank Wenzel (*George Allen & Unwin Ltd, 86 pp., 35s.*)

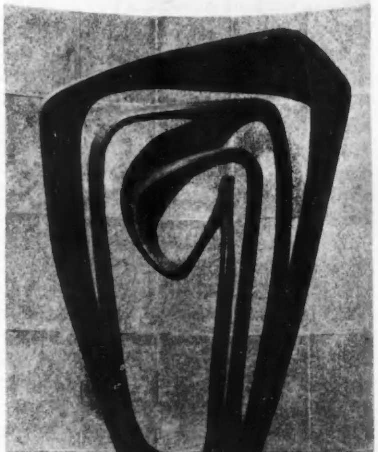
Those who love the buzzard as he wheels majestically overhead, and wish to know of him, will welcome from Denmark Mr. Frank Wenzel's account, beautifully illustrated from his own photographs. Migration, courtship, the incubation period, the trial flight, the variety and distribution of food—fifty mice a day in the breeding season—are all noted; he has heard the cheep of the chick in the egg three days before the shell is broken, has watched the death of the adder and the escape of the squirrel. This book would make a most delightful birthday present to any naturalist, young or old. G. F. ABERCROMBIE

Adventures in the World of Science

By Charles G. Abbot (*Washington, D.C., Public Affairs Press, 1958, vii+149 pp., $3.50*)

Dr Abbot was Secretary of the Smithsonian Institution in Washington, D.C., from 1928 to 1944, and has been a Smithsonian Research Associate since 1944. This is an autobiographical account of his carreer as a scientist. He describes his years at the Institution, his association with early research in solar energy, his association with the experiments of famous scientists of the past sixty years, and gives us his impressions of the U.S. Presidents, Grover Cleveland, William McKinley, Theodore Roosevelt, Herbert Hoover, and Franklin D. Roosevelt, whom he knew personally. The book concludes with some remarks on Dr Abbot's latest findings on the potentialities of solar energy and weather forecasting.

Barbara Hepworth's "Meridian" which stands outside the main entrance of State House, High Holborn, London.
Photograph by courtesy of David Farrell



SCIENCE ON THE SCREEN

Television

February television has seen some really formidable science broadcasts to schools, especially on BBC. A series of broadcasts by distinguished scientists has been transmitted (and later repeated) on a number of mornings at 11.35 a.m., in a new series, "Science for Sixth Forms". There is, of course, no really effective adult audience at this particular hour. At the same time, the more elementary afternoon BBC schools' science broadcasts have continued. This concurrent organising of both advanced and elementary school courses is a healthy advance and will doubtless grow more in the future. The science for sixth forms is not yet in the form of fully organised courses, as are the elementary broadcasts. At the moment they are "star-turn" programmes by specialists of international reputation. No doubt we shall soon see solid, long-term science courses laid on for the seniors as well as for the juniors. At least a good beginning has been made.

ITV have a comprehensive schools' spring programme, too, but this is also restricted to the younger pupil. "Endless Adventure", which can be described as an introduction to a comprehensive elementary General Science course, continues. It is a long-established favourite, although naturally it has had occasional misfires. "The World Around Us", beginning with astonomy, runs through to geophysics and promises a good deal of exciting material, especially about coal, fire, and fire at work. Typical of this programme course was No. 3, on February 4, entitled "Inside the Earth", presented by J. Ottaway. Starting off with some light-hearted sand-digging film, we were adroitly led to considerations of the earth's crust, mantle, and core. The now familiar ammonium bichromate model of an active volcano was demonstrated. This bears and deserves frequent repetition and never fails to excite admiration in both young and old. The broadcast was completed by illustrations of earthquake damage. This was essentially very good school-teaching, for not only was the effective content recapitulated in a good summary (an absolute necessity in the schools), it was strengthened by the device of a visual summary, using selected excerpts from the film sequences shown earlier in the lesson. The production team, A. Royds, F. Hall, and A. Martin are doing well with this series.

It so happened that the lesson just considered ended with an attractive short film entitled *The Cooper.* Although good, it had nothing at all to do with the previous main content of the lesson. Was it merely a stop-gap through bad timing? If not, it was a strange sweet course following the main dish; a mixture of menus.

Even if we exclude the official schools' broadcasts, which are issued to a captive audience during school hours, much of the remaining scientific output of the month was also addressed to the young. Just at the end of January A. Garratt lectured at 5.40 in Children's Hour, on "Gyroscopes". Mr Garratt is one of the most competent of science broadcasters, on either channel, but on this occasion he was not quite as illuminating as usual. To begin with, at no time did he really *define* what a gyroscope is, but curiously enough for him, seemed to take it for granted that all the members of his vast youthful audience knew already the meaning of the word. This I doubt very much indeed, despite the fact that one can buy gyroscopic toys. The gyroscope is formidably difficult to explain well, and Mr Garratt's explanation of the gyrocompass, although impeccably correct, must certainly have been obscure to most of his youthful audience. This broadcast, it must reluctantly be admitted, was definitely over-technical, a most unusual lapse for the experienced Mr Garratt. He was not helped in his difficult task by some bad film timing on the production side. It should be borne in mind that the Children's Hour must contain in its audience a very large number of girls as well as boys, and I feel that this programme must have been tedious for most of them.

One of the few adult science programmes of the month was another of the underwater films by Hans and Lotte Hass on BBC. Entitled *The Outsiders,* we were fascinated by examples of some unusual crabs, corals, shellfish, and sharks whose habits deviate markedly from the normal for their species. This type of broadcast cannot be anything other than film, and as we have long argued film is by no means the best kind of television, being an imperfect exploitation of the medium. Yet such good lively film is the next best thing to a live programme and forms a delightful addition to the repertoire of science broadcasting.

"Frontiers of Science", produced by J. McCloy, made a welcome reappearance on BBC on February 10. In this, the mystery of the mechanism and meaning of Sleep was discussed by Dr Walter and Dr Oswald. A simplified, but enormous, diagram of the brain was screened to illustrate the functioning of the reticular formation, the lecturer being in fact quite dwarfed by the gigantic diagram. We fail to see any real virtue in such mere size, especially as the gross oversimplification in the diagram deliberately restricted the details to a few general outlines. The only real justification for very great enlargement is the need to show fine detail not observable on a small diagram.

This broadcast employed some brilliant animated diagrams illustrating brain mechanisms. As to the main content, the lecturers were honest enough in admitting that we still know little about sleep, its mechanisms and its basic functions. It is perhaps apt to recall in this connexion a remark we once heard some years ago from a distinguished President of the Royal Society who asked, rather sadly, how we can expect to understand the brain when we only have a brain with which to do it! As he pointed out, we really need something outside ourselves.

We were glad to see on BBC a new interviewer of scientists in the person of Mr D. Lutyens. We have previously had occasion to praise his work on the regular Sunday teen-age science programme on ITV. He is critical and sympathetic and asks the right questions at the right moments. He has the gift of summarising a complex situation with admirable clarity. We predict a successful future for Mr Lutyens in this role. He makes a valuable addition to the minutely small company of good interviewers of scientists.

S. TOLANSKY

Husk

35 mm., Eastman colour, sound, 13 minutes. Produced for Allen & Hanburys Ltd by Verity Films in association with the Film Producers Guild Ltd. Producer, Oswald Skilbeck; directed by Gordon Stewart. (*Available on free loan to Agricultural Organisations such as the National Farmers Union, Young Farmers Clubs, and to any concerned with veterinary work, from The Veterinary Division of Allen & Hanburys, Bethnal Green, London, E.2*)

This film is part of Allen & Hanburys' publicity campaign for their new product "Dictol". They claim this to be the first vaccine in the world effective against the parasitic worm disease, husk or hoose. This is an incurable complaint caused by the helminth, *Dictyocaulus viviparus*, which is a thread-like worm living in the lungs of cattle. The use of a vaccine consisting of dead helminth is not effective, but treating the live creature with x-ray has produced a strain, which, though apparently active, does no damage to the animal and makes it immune to the disease.

As the vaccine has a comparatively short life, it is at present only available to veterinarians. This is also considered to be important, because only clinical knowledge and thorough examination can decide whether the beasts to be treated are in a good state of health and free from infection.

The film follows an increasing modern tendency, and begins before the titles with a short and quite effective sequence: "£1,000,000" flashes on the screen; it changes to "£2,000,000", and then £3,000,000". The commentary explains that the annual loss due to husk is in this order. The film goes on to show the characteristic posture of cattle suffering from the disease.

The research from which this discovery stems was carried out at Glasgow University. This is indicated in the film by rather vague shots of the university and a man looking through a microscope. In fact, throughout the film there is a tendency to put all the meat in the commentary and use visuals largely to keep the eyes occupied. This technique, which was used very successfully by the "March of Time" series, has impact but is slightly defeatist. It indicates that the film-maker has not been able to find visuals which really help to tell his story.

The life cycle of *Dictyocaulus viviparus* is shown in rather primitive diagram, which did not stand out as clearly as it might because the colour contrasts were not sufficient. A stereotyped cow is used as a background, the reds used to show the progress of the parasitic worm do not show up too well against the darker colours.

The film shows the dissections of a healthy and an unhealthy lung. It also shows, rather sketchily, the examination of the calves used for the preparation of the vaccine. It then shows the method of oral administration. It ends with the commentary remark that husk is incurable. This strikes a discouraging note, for it might have been better to reverse the last two sentences of the commentary, and say, "Although husk, when contracted,

is incurable, this vaccine can give immunity."

Some of the scientific points had been skated over quickly. For example, the lung examination was merely indicated by a cursory use of the stethoscope. On the other hand, many scientific terms had been used in the commentary. The producer said that this had been done as cold-blooded flattery. The terms would be familiar to the younger generation of university-educated farmers; it was intended to be taken as a compliment by the others. It is a good thing never to talk down to the audience, but there were a number of words used in the commentary which are unlikely to be understood by any but a technical audience.

Direct technical terms can be justified. They add to the vocabulary and to the sense of scientific accuracy that a technical film of this kind requires to give it authenticity. Your reviewer picked out one word—"motile"—none of the other members of the audience (agricultural experts, veterinarians, and at least one doctor) had noticed this as being at all unusual. The use in this case of a simple word like "active" would have made a deeper impact on a farming audience.

When writing critically about a film it ts comparatively easy to describe its faults so fully that they appear to outweigh its virtues. Undoubtedly this film, if it is shown as intended, with a representative of Allen & Hanburys there to answer questions, will be most valuable. It is only part of a large-scale drive to publicise "Dictol". No aid should be considered entirely on its own, unless it is to be used on its own. This film as part of an armoury should be an effective weapon.

An interesting point is that it took seven weeks from scripting it to screen. This is little short of lightning speed in comparison with usual production time for this sort of undertaking, including animated diagram. It shows that there must have been energetic and co-ordinated team-work between Allen & Hanburys and Verity Films. They are to be congratulated on the results in the circumstances.

If the script had been worked on longer, the visuals chosen more carefully, and the commentary orientated more directly to a farming audience it could have been a much better film. Nevertheless, it will do its job because it is giving an answer to a very real problem. Wisely it has not indicated the cost of the treatment or the length of time in which complete immunity is assured. These things will only be known with time and continued research. The information will be made public as it becomes available. It is an essential thing that scientific films sponsored by industry as part of sales campaigns should be honest and objective. This film gives the impression that it is down-to-earth, truthful, and accurate. Therefore, in spite of all criticisms of detail, it must be said to fulfil its purpose.

L. GOULD-MARKS

FAR AND NEAR

New Fellows of The Royal Society

At a meeting on March 24, 1960, the following were elected to the Fellowship of the Royal Society:

BINNIE, MR ALFRED MAURICE, Reader in Engineering at the University of Cambridge, Department of Engineering. Distinguished for his contributions to engineering science, particularly in the field of hydraulics.

BROWN, PROF. ROBERT HANBURY, Professor of Radio Astronomy in the University of Manchester, Jodrell Bank Experimental Station. Distinguished for his many contributions to radio astronomy, particularly on galactic and extra-galactic radio emissions.

CHRISTOPHERSON, PROF. DERMON GUY, O.B.E., Professor of Applied Science in the University of London, Imperial College of Science and Technology, Department of Mechanical Engineering. Distinguished for his researches into the deformation and cutting of metals and for his work on explosive weapons.

DALITZ, PROF. RICHARD HENRY, Professor of Physics in the University of Chicago, Enrico Fermi Institute for Nuclear Studies. Distinguished for his numerous contributions to nuclear theory and the physics of elementary particles.

DAVIDSON, PROF. JAMES NORMAN, Gardiner Professor of Physiological Chemistry in the University of Glasgow. Distinguished for his work on the structure, distribution, and biosynthesis of ribose nucleic acid and deoxyribose nucleic acid.

DEWAR, PROF. MICHAEL JAMES STEUART, Professor of Chemistry in the University of Chicago. Distinguished for his studies of chemical structure and for his contributions to the application of quantum theory to organic chemistry.

DUKE-ELDER, SIR STEWART, G.C.V.O., Ophthalmic Surgeon and Director of Research at the London University Institute of Ophthalmology. Distinguished for his contributions to ophthalmic medicine, pathology, and physiology.

ESSEN, DR LOUIS, Deputy Chief Scientific Officer at the National Physical Laboratory, Teddington, Middlesex. Distinguished for his work on the precise measurement of frequency and of the velocity of light.

EVANS, DR DAVID GWYNNE, Director of the Medical Research Council Biological Standards Control Laboratory, London. Distinguished for his investigations on the pathogenesis and prophylaxis of anaerobic wound infections and whooping cough, and for his work on biological standards.

FALCON, MR NORMAN LESLIE, Chief Geologist of the British Petroleum Company, London. Distinguished for his researches in tectonics and stratigraphy in connexion with the exploration for oil.

GORER, DR PETER ALFRED, Reader in Experimental Pathology at the University of London. Guy's Hospital Medical School. Distinguished for his work on the immunological genetics of tissue transplantation.

HEATH, PROF. OSCAR VICTOR SAYER, Professor of Horticulture in the University of Reading. Distinguished for his work in plant physiology and in particular the mechanism of stomata.

HOLROYD, DR RONALD, a Deputy Chairman of Imperial Chemical Industries Ltd, London. Distinguished for his work on the chemistry and engineering of synthetic fuel production.

HUXLEY, DR HUGH ESMOR, M.B.E., Member of external staff of the Medical Research Council, Department of Biophysics, University of London, University College. Distinguished for his work on the fine structure of muscle and on the mechanism of muscular contraction.

KENDREW, DR JOHN COWDREY, Deputy Director of the Medical Research Council Unit for Molecular Biology, Cavendish Laboratory, Cambridge. Distinguished for his work on the three-dimensional analysis of myoglobin by direct x-ray diffraction methods.

KITCHING, DR ALWYNE, O.B.E., Reader in Zoology at the University of Bristol, Department of Zoology. Distinguished for his contributions to the physiology of protozoa and to marine ecology.

MACDONALD, DR DAVID KEITH CHALMERS, Principal Research Officer, Division of Pure Physics, National Research Council of Canada, Ottawa. Distinguished for his investigations of the thermal and electrical properties of metals with particular reference to the study of electron interactions.

PICKERING, SIR GEORGE WHITE, Regius Professor of Medicine in the University of Oxford, Department of Medicine. Distinguished for contributions to clinical science, in particular to our knowledge of the causes of high blood-pressure.

PORTER, PROF. GEORGE, Professor of Physical Chemistry in the University of Sheffield, Department of Chemistry. Distinguished for his work on flash photolysis and its applications to the study of free radicals and chemical processes.

ROTH, DR KLAUS FRIEDRICH, Reader in Mathematics at the University of London, University College, Department of Mathematics. Distinguished for his solutions of fundamental problems in the theory of numbers.

SESHADRI, PROF. TIRUVENKATA RAJENDRA, Professor of Chemistry in the University of Delhi, Department of Chemistry. Distinguished for his studies of the chemistry of natural-occurring compounds, particularly flavonoids.

TAYLOR, PROF. JAMES HAWARD, Professor of Geology in the University of London, King's College, Department of Geology. Distinguished for his researches into the geology of ore deposits, particularly the iron ores of the Midlands.

TOWNSEND, DR ALBERT ALAN, Assistant Director of Research at the University of Cambridge, Cavendish Laboratory. Distinguished for his experimental and analytical contributions to the theory of turbulent motion in fluids.

WAIN, PROF. RALPH LOUIS, Professor of Agricultural Chemistry in the University of London, Wye College, Department of Physical Sciences. Distinguished for his research in plant auxins and systemic herbicides.

WILLMER, DR EDWARD NEVILL, Reader in Histology at the University of Cambridge, Department of Physiology. Distinguished for his work on cells, their growth and metamorphosis and on colour vision.

Dounreay Fast Reactor

The first series of experiments with the fast-breeder reactor at Dounreay (Caithness) have been completed. The reactor will now be shut down for about three months while changes are made in the "core" of the reactor so that a wider variety of types of fuel can be tested. As an experimental tool, the Dounreay reactor has been designed so that minor and major components may be easily replaced when different designs have to be tested.

The reactor started operation at low power on November 14, 1959. Since then, an intensive programme of physics and engineering research has been carried out, designed to provide information for the operation of this experimental reactor at

higher power levels, and to help in the design of a fast-breeder reactor prototype.

Director of Science Museum

Sir David Eccles, Minister of Education, has appointed Dr D. H. Follett, M.A., Ph.D., F.Inst.P. to be Director of the Science Museum in succession to Dr T. C. S. Morrison-Scott.

Dr Follett will be succeeded by Mr D. Chilton as Keeper of the Department of Electrical Engineering and Communications in the Science Museum.

Sixth Commonwealth Mycological Conference—1960

The Sixth Commonwealth Mycological Conference will be held from Friday, July 15, to Friday, July 23, 1960, both days inclusive, at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1, adjoining the Senate House of the University of London.

Many topics for discussion have been suggested and these can conveniently be grouped under the following headings: Taxonomy, Forecasting and Assessment of Diseases, Root Diseases, Diseases of Cereals, Seed Pathology, Virus Diseases, and Fungicides. The Director would appreciate early advice from official correspondents as to the suitability of this programme and/or additional items for inclusion, and also of offers of papers for presentation, preferably by the author.

Inquiries to: J. C. F. Hopkins, Commonwealth Mycological Institute, Ferry Lane, Kew, Surrey.

Jean Rostand—Kalinga Prize for 1959

Jean Rostand, French scientist, science writer and philosopher, has been selected as the winner of the annual international Kalinga Prize for the popularisation of science, it was announced recently by UNESCO.

M. Rostand received the award at an official ceremony in April at UNESCO House. The prize of £1000 sterling is offered by the Kalinga Foundation, set up to contribute to economic, social, and cultural progress in the Indian state of Orissa. Its winner is chosen annually by an international jury appointed by UNESCO. The purpose of the award, as stated by its donor, Mr B. Patnaik, an Indian industrialist, is to offer recognition to leading interpreters of science and also to strengthen links between India and scientists of all nations.

The award of the Kalinga Prize to M. Rostand, who is sixty-six years old, comes as recognition for a long and brilliant career as a biologist and a writer, a career which was crowned last year by his election to the Académie Française. He has achieved fame both for his work on heredity and genetics, based upon three decades of experimentation with frogs and toads, and for his forty-odd books on these and many other subjects.

Writing is hereditary for Jean Rostand. He is the son of Edmund Rostand, the famous French playwright who gave the world Cyrano de Bergerac, and his first books were actually works of social satire.

Teaching Science Talent Search

The first competition of its kind in the British Commonwealth for science teachers has been begun by the publication *Teaching Science*. It is called the *Teaching Science* Talent Search, and it is designed to encourage science teachers to develop and report on their own original contributions to the teaching of science and to ensure their dissemination.

The aim of the organisers is to help to promote the general advance of science instruction.

£100 in cash prizes will be distributed by *Teaching Science*—which is published by Junior Club Publications Ltd, 5 Great James Street, London, W.C.1—on the basis of recommendations made by an independent Awards Committee. The money has been provided through the generosity of Messrs Griffin and George Ltd, the laboratory furnishers.

The members of the Awards Committee are: Dr Cyril Bibby, M.A., M.Sc., Ph.D., Principal of Kingston-upon-Hull Training College; Miss I. C. Joslin, B.Sc., former Headmistress of the Francis Holland School, London; and Mr N. F. Newbury, M.A., M.Sc., F.R.I.C., Director of Education, St Helens County Borough, Lancashire.

Awards are to be made in two groups: *Group S*—to science teachers in all types of secondary schools for contributions connected with teaching up to and including "O" Level G.C.E; and *Group P*—to teachers concerned with science teaching in primary schools. In each Group there will be four awards totalling £50 in all.

The kind of entries that are being sought for are those concerned with the presentation of a new idea or the development of an old idea. They may revolve around a new technique or content in classroom work, the development of special interests in the pupil, the fostering of the outstanding child or the development of the backward child, or the encouragement of group activities in the classroom or outside. The fostering of special relations with local industry, or the local museum or library, or the use of new materials is included.

Because it is recognised that schools are unevenly equipped and that teachers differ in personality, factors such as resourcefulness and the best use of limited facilities will be taken into account.

The closing date for entries is May 31, 1960, and to date there have been 100 entry forms already despatched.

The ground-effect machine (GEM). It was developed and built by Gyrodyne Company of America, St James, N.Y., under a Bureau of Aeronautics, U.S. Navy contract. The GEM is designed to carry one man at a distance of about 6 in. above the ground. It is powered by a Porsche 1600 c.c. engine developing 62 h.p. The Gyrodyne GEM has successfully completed flight tests required under the contract and is now ready for extended testing.

The International Yard and Pound

The Directors of the standards laboratories in Ottawa, Canada; Lower Hutt, New Zealand; Washington, United States; Teddington, England; Pretoria, South Africa; and Sydney, Australia have discussed the existing differences between the values assigned to the yard and to the pound in different countries. To secure identical values for each of these units in precise measurements for science and technology, it has been agreed to adopt an international yard and an international pound having the following definitions:

the international yard equals 0·9144 metre; the international pound equals 0·45359237 kilogram.

It has also been agreed that, unless otherwise required, all non-metric calibrations carried out by the above laboratories for science and technology will now be made in terms of the international units as defined as above or multiples or submultiples.

Classified Advertisements

OFFICIAL APPOINTMENTS

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APPLICATIONS are invited for the post of Entomologist in the Entomology Branch of the Department of Research and Specialist Services.

Applicants must be graduates, preferably with Honours, having Entomology or Zoology as a principal subject. A knowledge of tropical or sub-tropical entomology would be an advantage.

Duties involve extension and advisory work on agricultural entomology, regulatory work in relation to plant quarantine and research on insects of economic importance where other duties permit.

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Application forms and further details from the Secretary (R), Rhodesia House, 429 Strand, London, W.C.2.

IONOSPHERIC ASSISTANTS required by FALKLAND ISLANDS DEPENDENCIES SURVEY for service in the ANTARCTIC for 2 years. Salary at a basic rate of £500 a year with extra allowances for qualification and experience. Officers appointed will be required to undergo course of training before leaving U.K. in October/November. Whilst in the Antarctic everything is provided free of charge including clothing, cigarettes, etc. Liberal leave on full salary. While on duty in U.K. an extra allowance of £150 a year is paid before departure and £200 a year on return. Candidates must have knowledge of radar and radio with some maintenance experience. The appointment will be made with the advice of the DSIR Radio Research Station.

Write to the Crown Agents, 4 Millbank, London, S.W.1. State age, name in block letters, qualifications, and experience, and quote M3C/52985/DI.

LECTURES AND COURSES

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26 JULY–9 AUGUST, 1960

to be held in Queen's College, Oxford, and University Science Departments. Laboratory and field courses of study for one or two weeks in Chemistry (Modern Analytical Techniques), Biochemistry, Microbiology and Living Organisms, special week-end courses in Radio-Chemistry and Viruses, and a lecture course on Aspects of Modern Chemistry. The courses are given by lecturers and demonstrators from the Departments of Inorganic Chemistry, Metallurgy, Biochemistry, Zoology and comparative Anatomy, Agriculture, Pathology, and the Dyson Perrins and Clarendon Laboratories; and attention is paid to students' preferences in individual work. The programme should be of interest to teachers of science, scientists, and technicians engaged in industry, members of adult classes and others who wish to extend their knowledge and understanding of science. Fee £10 per week inclusive (reduced rate for students from certain adult classes £7 7*s*.); week-end courses: Viruses £3 5*s*., Radio-Chemistry £4 17*s*. 6*d*.

Full particulars may be obtained from the Secretary, Science Summer School, Oxford University Delegacy for Extra-Mural Studies, Rewley House, Wellington Square, Oxford. Telephone: Oxford 57203.

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